

# NATIONAL GEOGRAPHIC



# Etna Ignites

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# ANTARCTICA

## A NEW AGE OF EXPLORATION

Produced by National Geographic Maps for National Geographic Magazine



GILBERT M. GROSVENOR, CHAIRMAN  
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NATIONAL GEOGRAPHIC MAGAZINE  
ALLEN GABBILL, CHIEF CARTOGRAPHER  
Washington, D.C., February 2002

**E**xtrêmes of climate and terrain found on no other continent confront all who venture to Antarctica. Almost a century ago iron men named Amundsen, Shackleton, and Scott raced exhaustion, starvation, frostbite, and each other to the South Pole. Planting Norway's flag, Amundsen won. Today's goal is knowledge: Satellite and ground-based observations help scientists understand the continent and its global climate impacts. The scope and detail achieved by Radsat's recent Antarctic mapping missions "was once unimaginable," according to Ghassem Asrar, NASA's associate administrator for earth science. "Scientists and engineers have literally created new ways to see the remotest reaches of the planet."

### Radarsat Fills in the Blanks

Maps of Antarctica's interior remained mostly white blanks into the mid-1980s. Satellites using visible light had produced detailed surface images, but their angles of view excluded more than 1.7 million square miles poleward of about 62° south latitude. Then in 1997 the Canadian Space Agency (CSA) directed its Radarsat I satellite in orbit, rotating its radar sensor toward the South Pole. The first Antarctic Mapping Mission, a joint project of CSA and NASA in the U.S., imaged the entire continent in just 18 days at a resolution many times finer than any other single satellite survey. Compiling Radarsat's 4,500 scans into the digital mosaic seen here required two years. Dark areas on the map indicate smooth ice and fine-grained surfaces, like new snow, that don't scatter the radar beam. Coarse surfaces—old granular snow, rough ice, and crevasses—break up the beam and appear bright. During its many passes over the continent the satellite scanned the surface in strips, producing the faint starburst effect that patterns the images. In 2000, Radarsat reimagined Antarctica's coast and most of its fast-moving glaciers, astonishing researchers with detailed images of recent change.

**A DIFFERENT WORLD**  
Able to survive months of dry, frigid darkness, lichens and mosses are Antarctica's dominant plants. The largest land animal is a wingless mite that's about a half inch long.

**THE LONGEST WINTER**  
Over hundreds of thousands of square miles of high plateaus, the sunless cold of winter lasts from April through September. From beginning to end of the season, temperatures average minus 81°F.

**THE BOTTOM OF THE WORLD**  
The South Pole, elevation 9,201 feet, is unlike any other place on Earth. Here the sun times out each year, around September 21, and sets once each year, around March 21. Thermometer readings drop below minus 90°F on more than 250 days. Precipitation falls from a clear sky almost daily; ice crystals drip from clouds too diffuse to be seen.

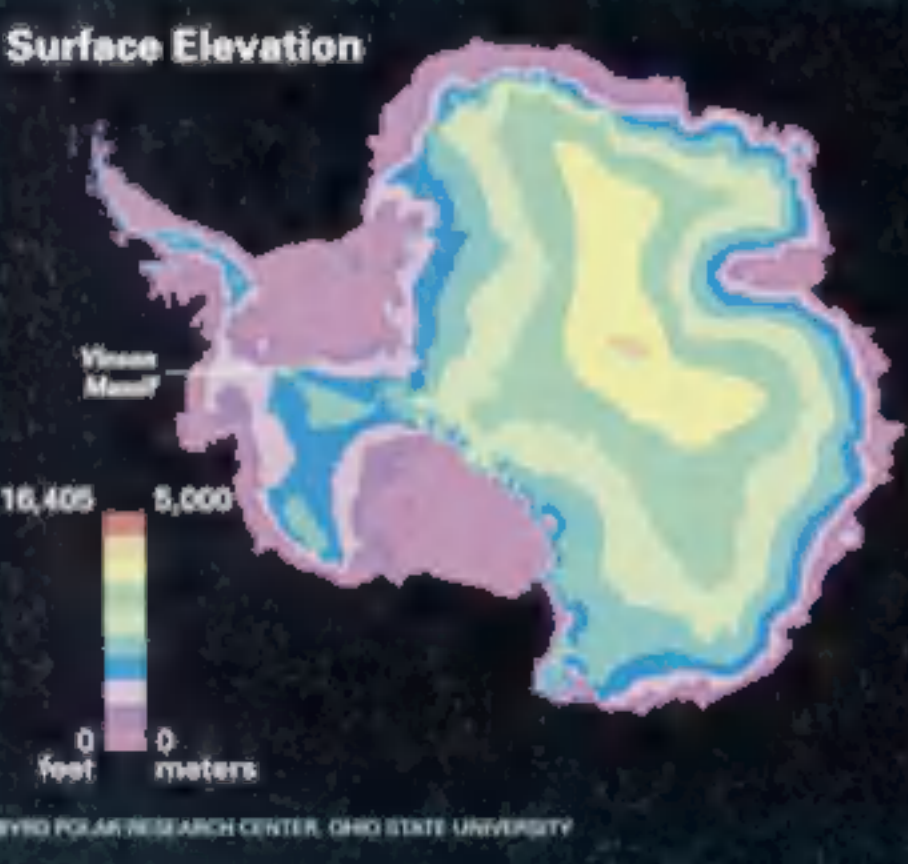
**MILDER SHORES**  
At Australia's Mawson Station the average temperature approaches a toasty 12°F. Year-round, typical highs and lows are separated by only about 10°F. In nearby Holme Bay a half dozen bird species share 75 tiny rocky islets. One species, the southern giant petrel, breeds nowhere else in the region.

### Continent for Cooperation

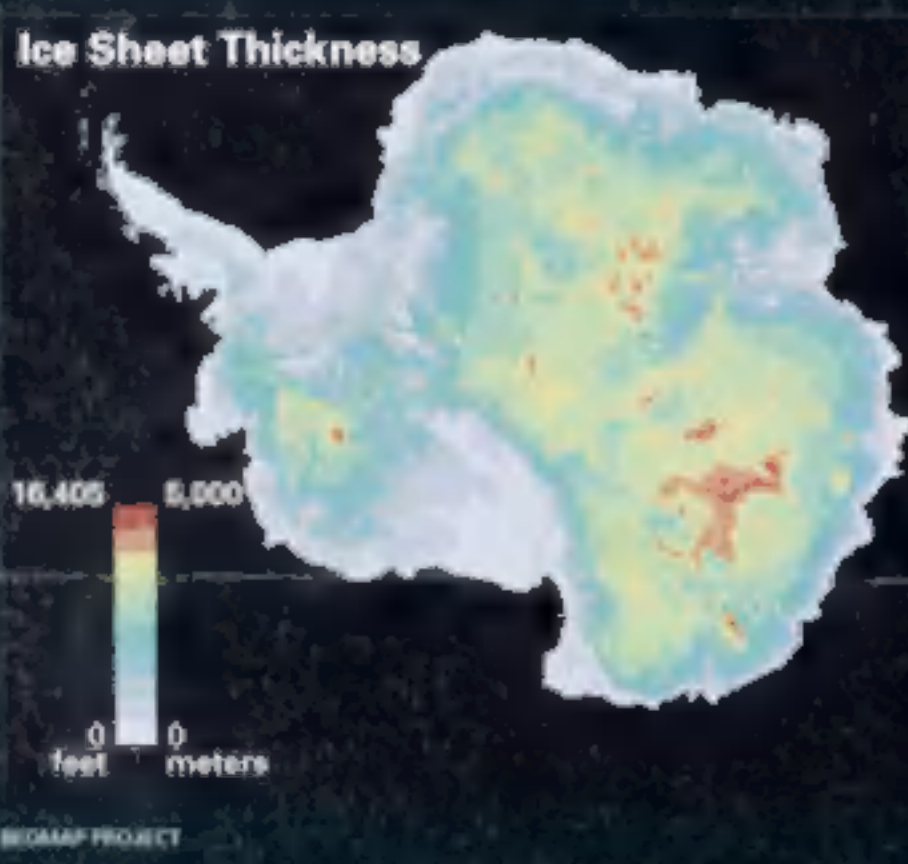
No single nation rules Antarctica. Since 1959 the terms of a multinational treaty have dedicated the continent to peaceful use and free exchange of scientific information. Some countries make territorial claims, but military activities and mineral exploitation have been prohibited indefinitely. Science is multinational too. Data from automated weather stations, critical to safe operations in this hostile setting, are freely shared. Individual nations maintain bases, but the research projects they support typically involve collaborators from many countries.



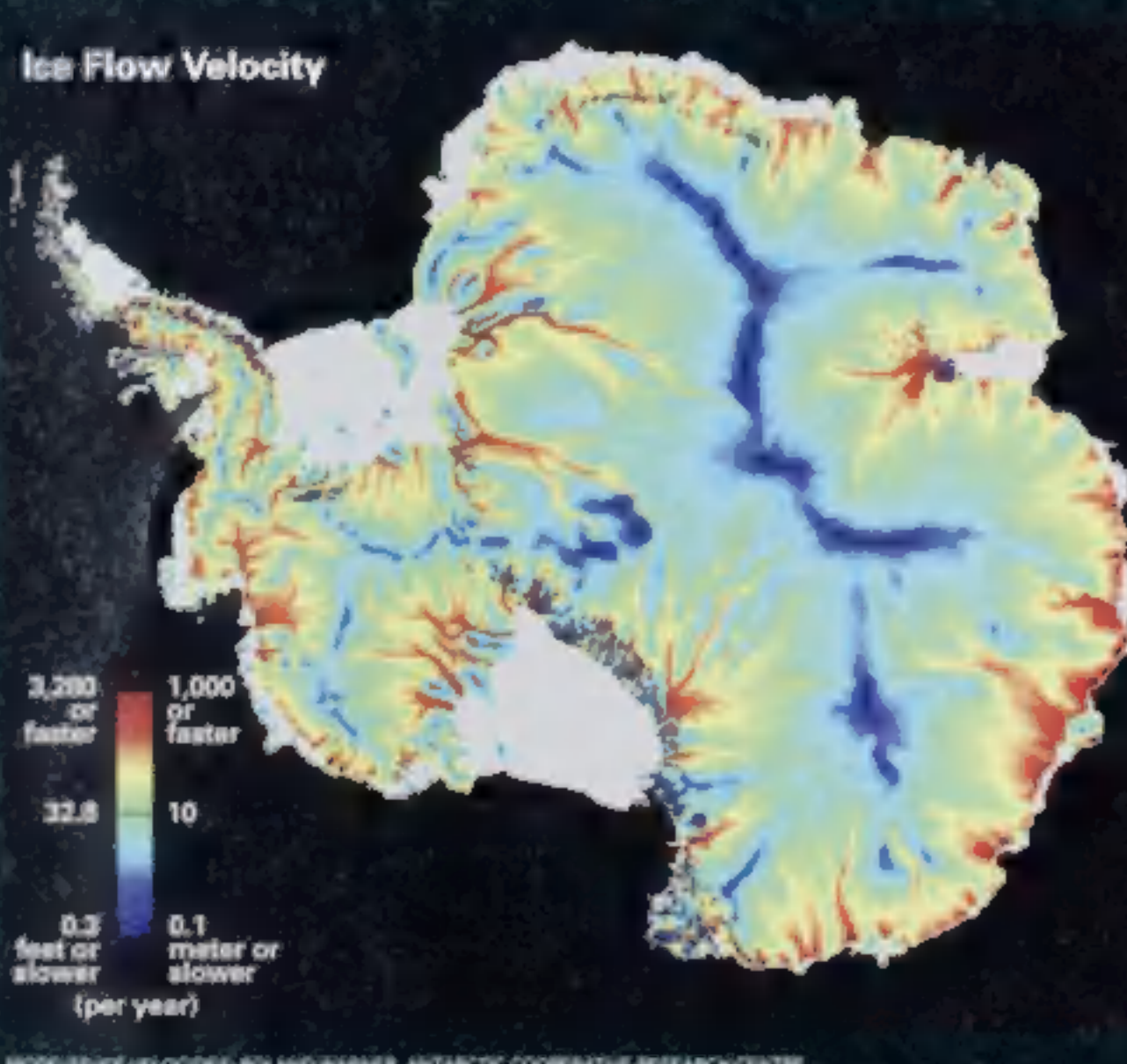
**ANTARCTIC PENINSULA**  
A mountain range welded to clusters of islands by a relatively thin coat of ice, this 800-mile-long peninsula is popular with penguins and other seabirds, including gulls, skuas, and petrels and provides important habitat for several species of seals.



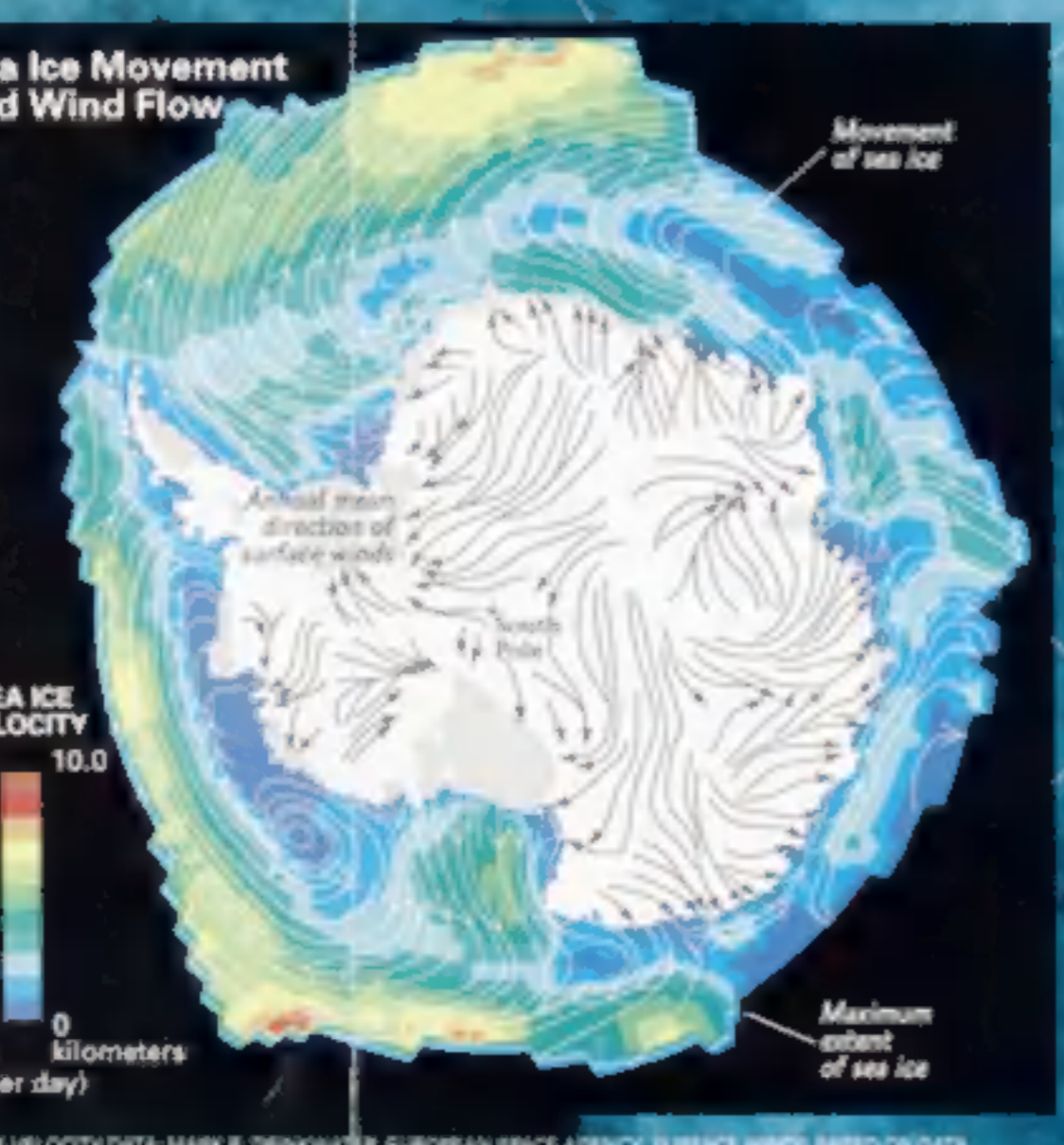
**ELEVATION OF THE ICE SHEET**  
Many mountaintops rise higher than Antarctica's highest point—Vinson Massif, 16,077 feet—but with an average elevation of 8,000 feet, the continent ranks as Earth's highest. Asia, its closest competitor, averages 3,000 feet. Roughly dome shaped, the ice sheet conceals most of the bedrock relief below. The 1,800-mile-long Transantarctic Mountains rival the Rockies in height, but only the peaks break through the ice.



**MEASUREMENTS OF A PARADOX**  
Ninety percent of the world's ice and 70 percent of the world's fresh water are found here, yet most of Antarctica is truly a desert. The snow equivalent of less than three inches of rain—a precipitation rate close to that of the Sahara—falls over the high interior of the continent each year. But snow and ice have been slowly accumulating on Antarctica for millions of years. More than 15,000 feet deep at its thickest, the mean depth of the ice exceeds 6,600 feet.



**ICE ON THE MOVE**  
Glaciologists once thought that ice motion in Antarctica's interior was slow and relatively uniform, with just a few fast-moving outlet glaciers and ice streams drawing ice from the interior down to the sea. A computer model based on new satellite data suggests a more intricate ice-movement pattern (left). Like rivers, coastal ice flows appear to be fed by complex systems of tributaries that penetrate hundreds of miles into major drainage basins.



**ULTIMATE WINDS**  
Katabatic winds—cold air pouring down glacial slopes—often blow at 50 miles an hour and can exceed 100 miles an hour. Offshore, circumpolar winds and currents push against sea ice that rings Antarctica each winter, driving the frozen ocean counterclockwise around the continent.



### Shifting Shorelines

Antarctica is a mapmaker's nightmare: By the time its outline is drawn, it is likely to have changed significantly. Less than half of the shoreline is rock or ice firmly grounded on rock. Floating ice shelves and advancing and retreating glaciers make up nearly 60 percent of the coast. Massive icebergs regularly calve from the ice shelves, knocking divots the size of small U.S. states from the outline of the continent. The coastline shown here is based on Radarsat's 1997 Antarctic Mapping Mission. Dotted blue lines show changes detected in the past four years.

**POPULATION DENSITY**  
New Zealand's Scott Base and the United States' McMurdo Station support the highest concentration of people in Antarctica. Antarctica has no indigenous population. Over the summer season as many as 28,000 scientists, support staff, and tourists arrive on the continent. Only about 1,000 stay through the winter.

### A Sea of Ice

When winter comes, the ocean surface around Antarctica begins to freeze. Snowing over an average of 30,000 square miles a day, the ring of sea ice eventually covers more than seven million square miles, an area larger than the continent itself. Floating on maps shows maximum extent of sea ice. Reducing the ocean's absorption of atmospheric carbon dioxide and blanching ocean atmosphere heat exchange, sea ice plays a role in shaping regional climate that in turn has impacts over much of the globe.

# ANTARCTICA

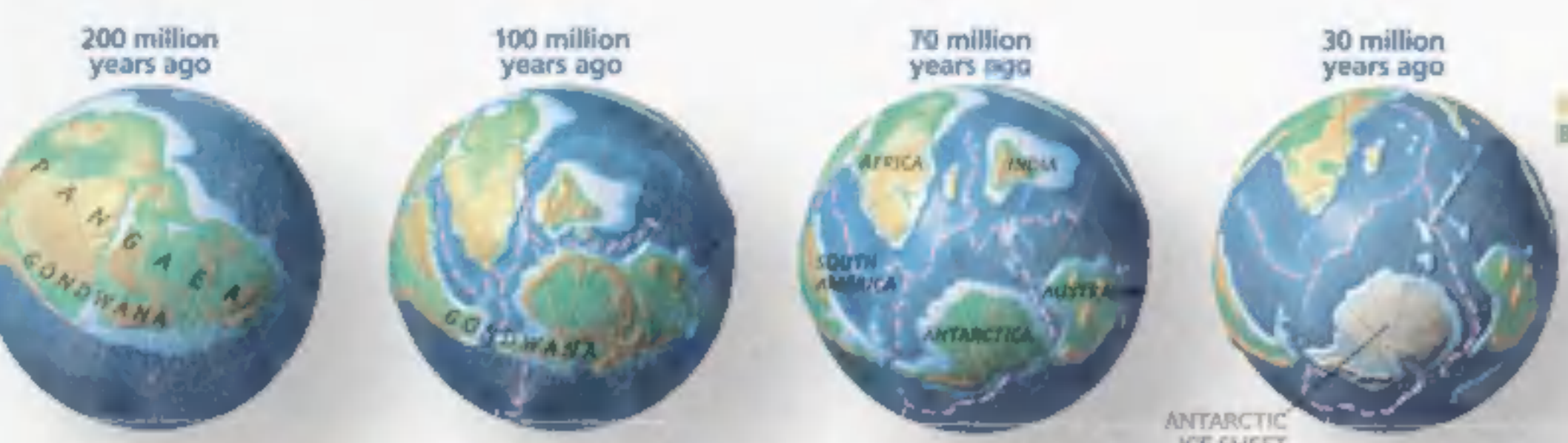
## A NEW AGE OF EXPLORATION

NATIONAL GEOGRAPHIC

Concealed under the southern ice sheet lie islands, mountains, valleys, and lakes. Using more than 2.5 million ice thickness measurements collected over 50 years—the BEDMAP consortium—have created a topographic map of Antarctica's bedrock landscape many times as detailed as earlier renderings. The BEDMAP terrain model appears at right overlaid with satellite imagery of surface details.

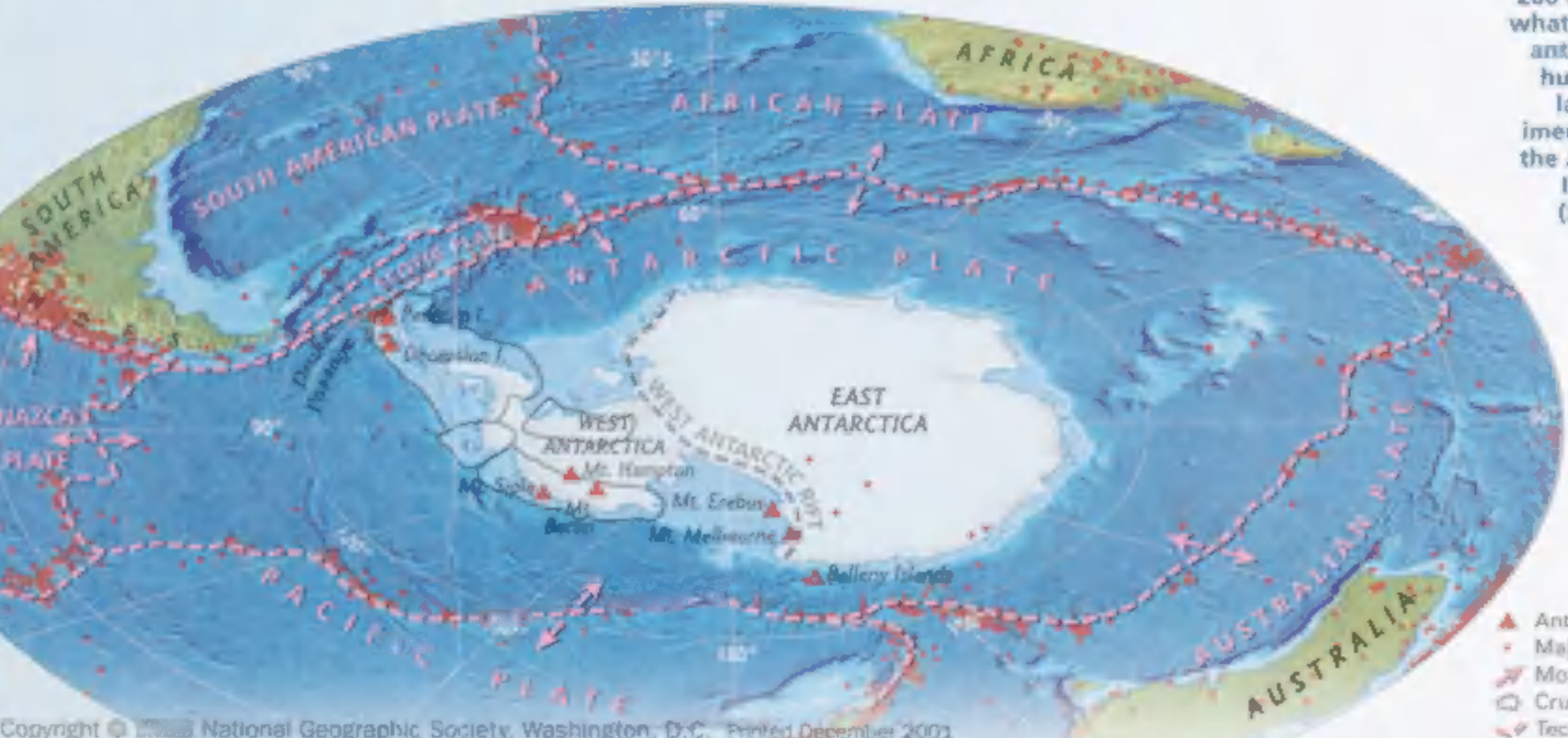
### CHANGE HEATS UP ON THE PENINSULA

Small numbers can have big effects. The Antarctic Peninsula's average temperature has increased by about 4°F since the 1950s. In that same time grasses have spread to new areas, penguin colonies have relocated, and some 3,000 square miles of coastal ice shelves have disintegrated. Is this the first sign of global warming, with ice meltdown and catastrophic sea level rise to come? Most experts say no. What's happening on the peninsula is a "regional warming in an area with a highly variable climate," says David Vaughan of the British Antarctic Survey. "By contrast, the climate in the rest of Antarctica is changing very slowly."



### AGES BEFORE THE ICE

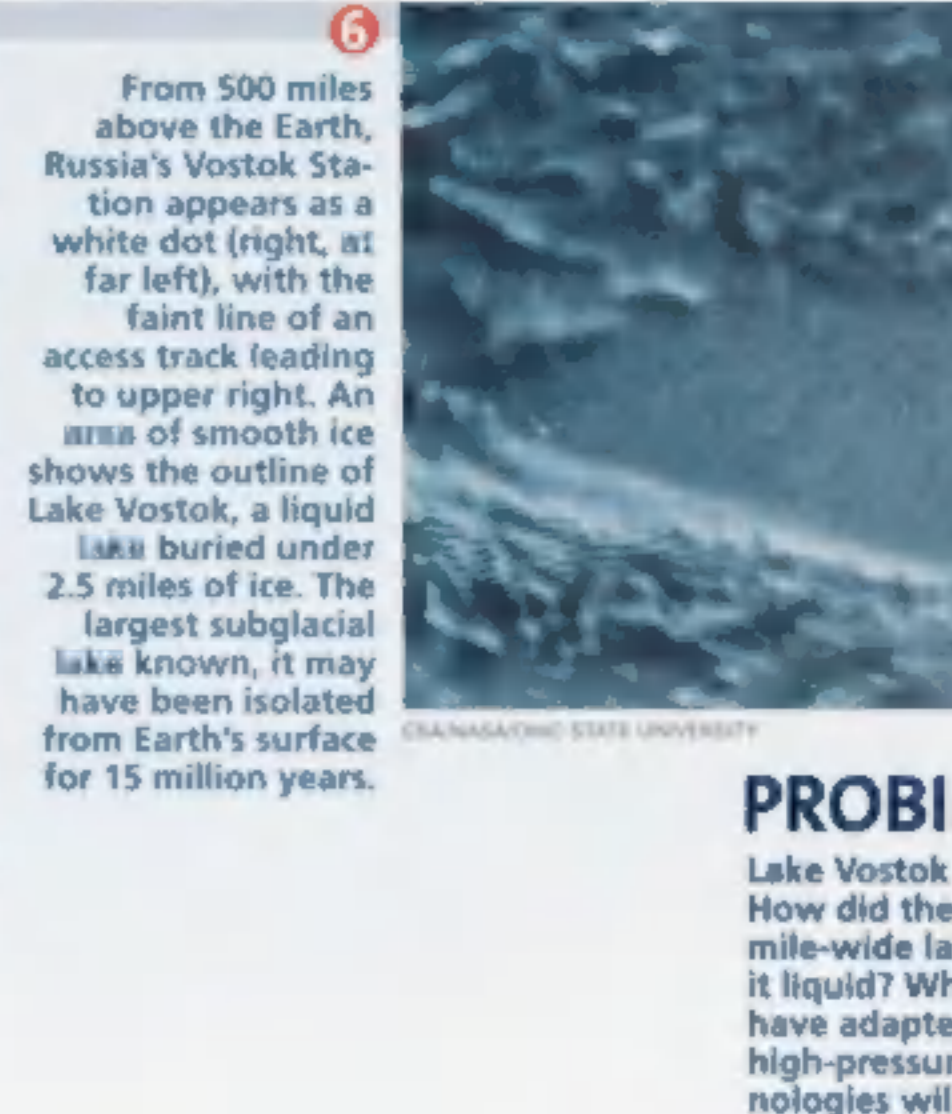
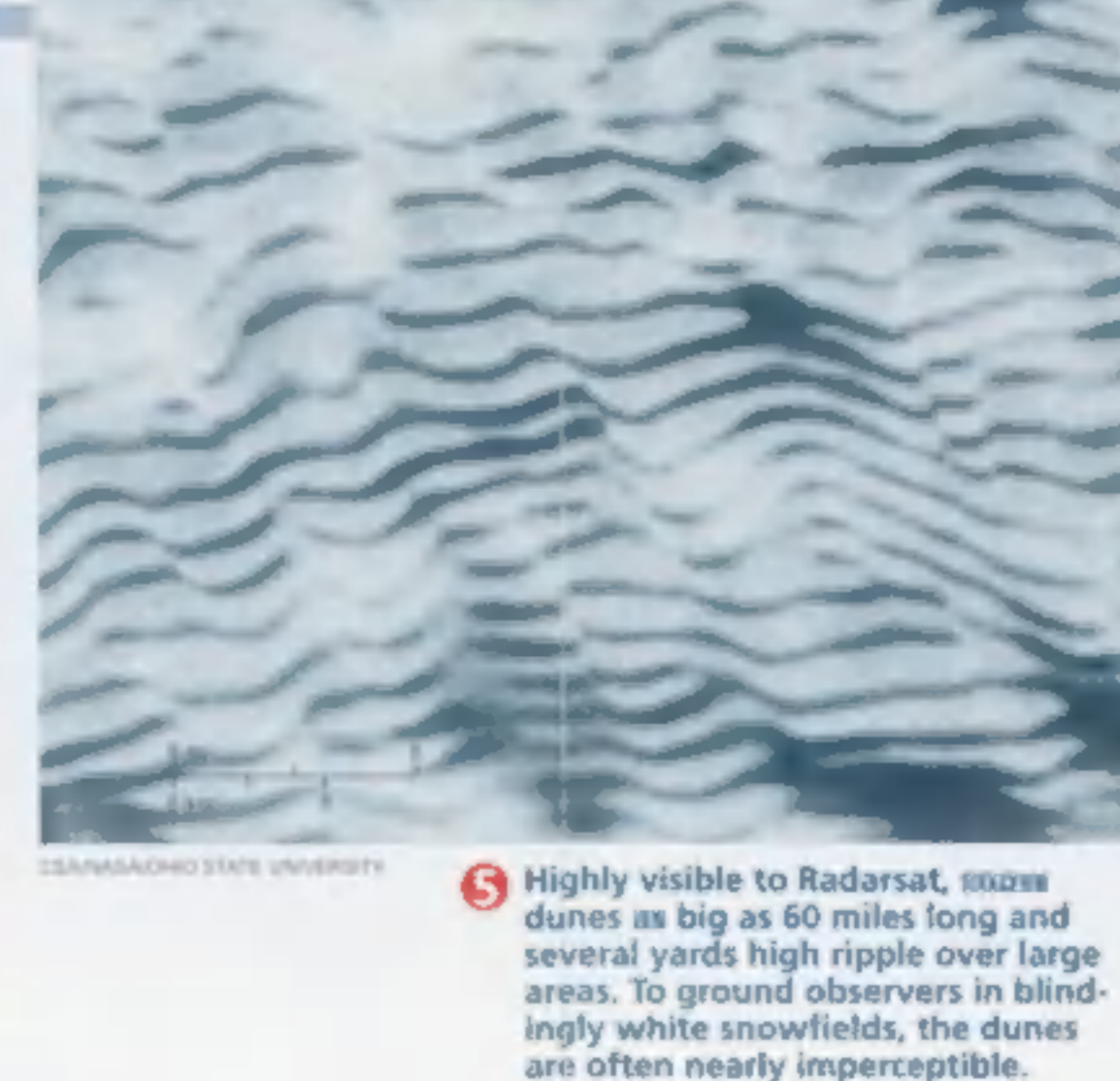
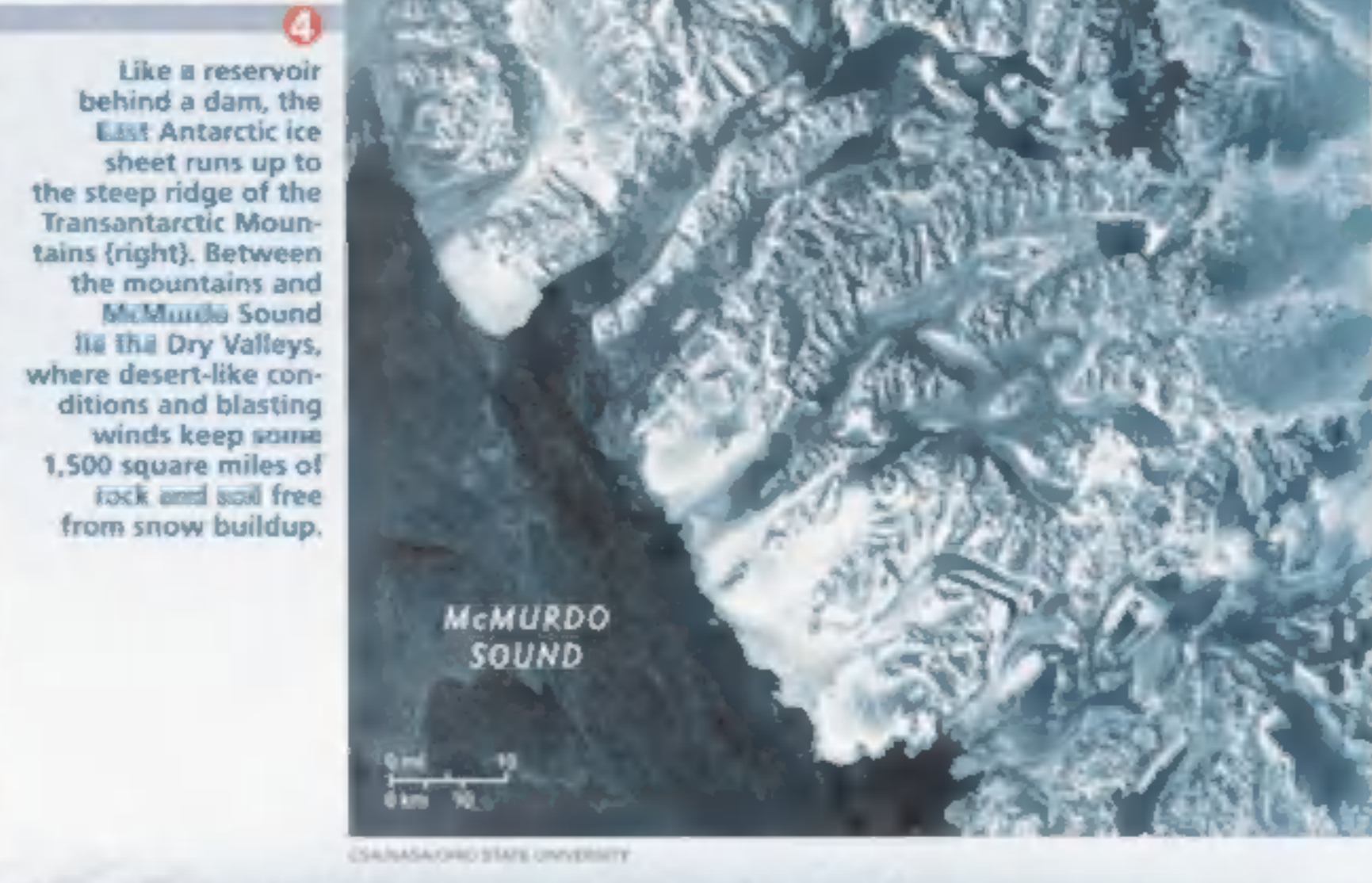
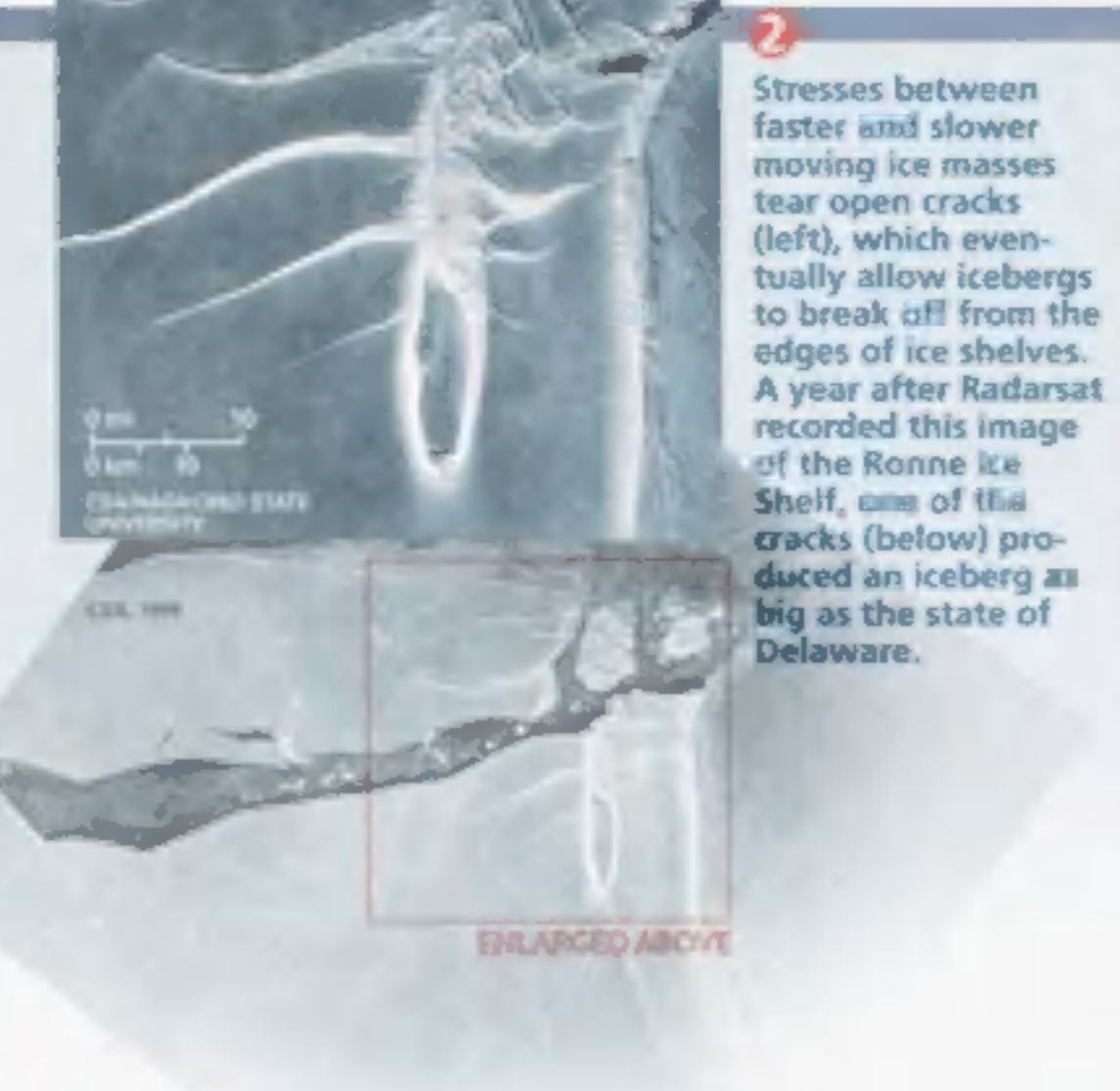
With less than one percent of its land surface exposed, Antarctica offers few easily opened windows into its geologic past. Once the moist, temperate core of the Gondwana supercontinent, Antarctica 70 million years ago was becoming a separate landmass. By 30 million years ago much of it was under ice. East Antarctica's bedrock is three billion years old, among the oldest on Earth. Built on a jigsaw puzzle of crustal blocks and dotted with volcanoes (below), West Antarctica is no more than 700 million years old.



### DETAILS, DAY OR NIGHT

Satellites that use visible light to gather images, like the Landsat 7 glacier scene at left, have created striking records of Antarctic terrain. They require sunlight and clear skies however. Canada's Radarsat system (image gallery at right), in contrast, can "see" the Earth's surface under almost any conditions, capturing high-resolution surface data unperturbed by winter's 24-hour darkness or summer's dense cloud cover.

**1** Byrd Glacier (left) plunges through a deep valley in the Transantarctic Mountains and into the Ross Ice Shelf, dropping more than 4,300 feet over a distance of 112 miles.



**2** Stresses between faster and slower moving ice masses tear open cracks (left), which eventually allow icebergs to break off from the edges of ice shelves. A year after Radarsat recorded this image of the Ronne Ice Shelf, one of the cracks (below) produced an iceberg as big as the state of Delaware.

**3** Multiple tributaries funnel into Lambert Glacier (above), draining 330,000 square miles of East Antarctica. Emptying into the Amery Ice Shelf, Lambert is 25 miles wide and nearly 250 miles long—one of the largest ice streams on Earth.

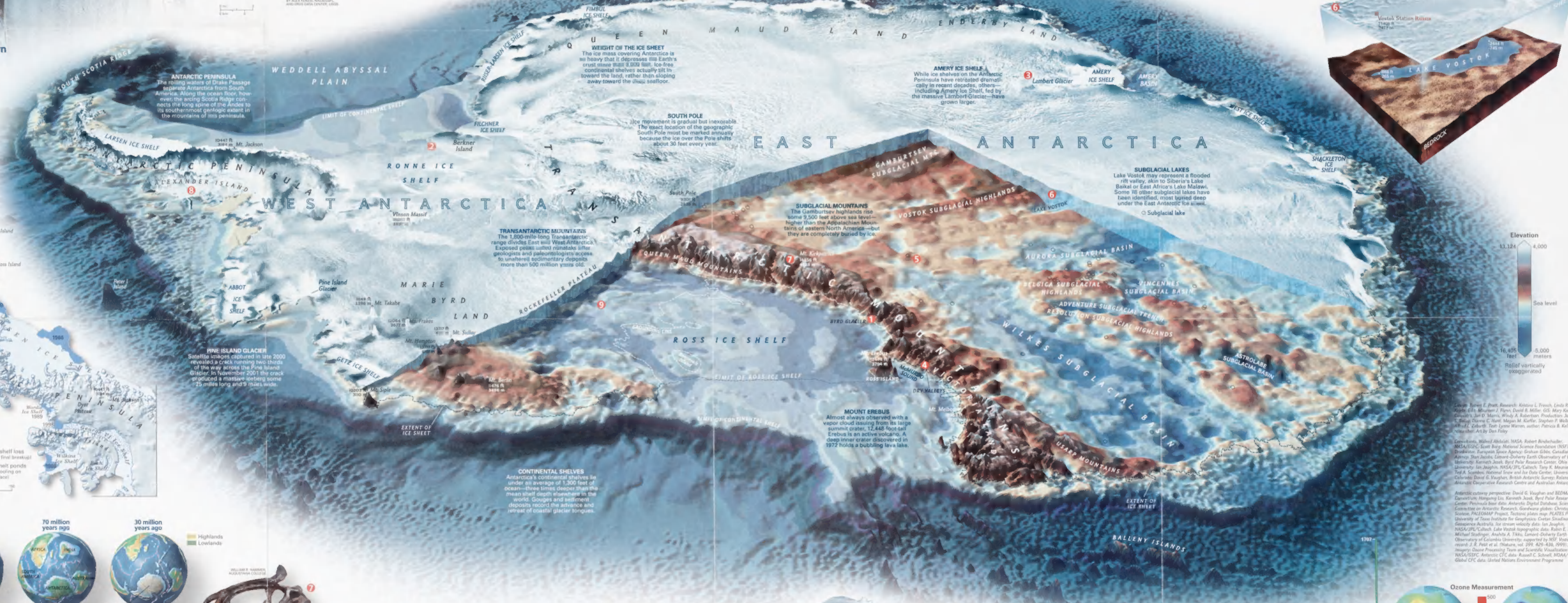
**4** Like a reservoir behind a dam, the East Antarctic ice sheet runs up to the steep ridge of the Transantarctic Mountains (right). Between the mountains and McMurdo Sound lie the Dry Valleys, where desert-like conditions and blasting winds keep some 1,500 square miles of rock and soil free from snow buildup.

**5** Highly visible to Radarsat, snow dunes as big as 60 miles long and several yards high ripple over large areas. To ground observers in blindingly white snowfields, the dunes are often nearly imperceptible.

**6** From 500 miles above the Earth, Russia's Vostok Station appears as a white dot (right, at far left), with the faint line of an access track leading to upper right. An area of smooth ice shows the outline of Lake Vostok, a liquid lake buried under 2.5 miles of ice. The largest subglacial lake known, it may have been isolated from Earth's surface for 15 million years.

### PROBING VOSTOK'S MYSTERIES

Lake Vostok tantalizes scientists. How did the 170-mile-long, 30-mile-wide lake form? What keeps it liquid? What life-forms might have adapted to its cold, dark, high-pressure depths? New technologies will be required to penetrate the ice cover, explore the lake, and collect study samples—all without contaminating this unique environment. Space researchers hope that tools developed for Vostok could someday lead to explore liquid seas under the frozen surface of Europa, one of Jupiter's giant moons.



**7** PINE ISLAND GLACIER Satellite images captured in late 2000 revealed a crack running two-thirds of the way across the Pine Island Glacier. In November 2001 the crack produced a massive iceberg some 15 miles long and 9 miles wide.

**8** TRANSANTARCTIC MOUNTAINS The 1,200-mile-long Transantarctic range divides East and West Antarctica. Exposed peaks and mountain ranges are geologists and paleontologists access to unsheltered sedimentary deposits more than 500 million years old.

**9** SOUTHPOLE The exact location of the geographic South Pole must be marked annually because the ice over the Pole shifts about 30 feet every year.

**10** MOUNT EREBUS Almost always observed with a vapor cloud issuing from its large summit crater, 12,448-foot-tall Erebus is an active volcano. A deep inner crater discovered in 1972 holds a bubbling lava lake.

**11** SUBGLACIAL LAKES Lake Vostok may represent a flooded rift valley, akin to Siberia's Lake Baikal or East Africa's Lake Malawi. Some 70 other subglacial lakes have been identified, most buried deep under the East Antarctic ice sheet.

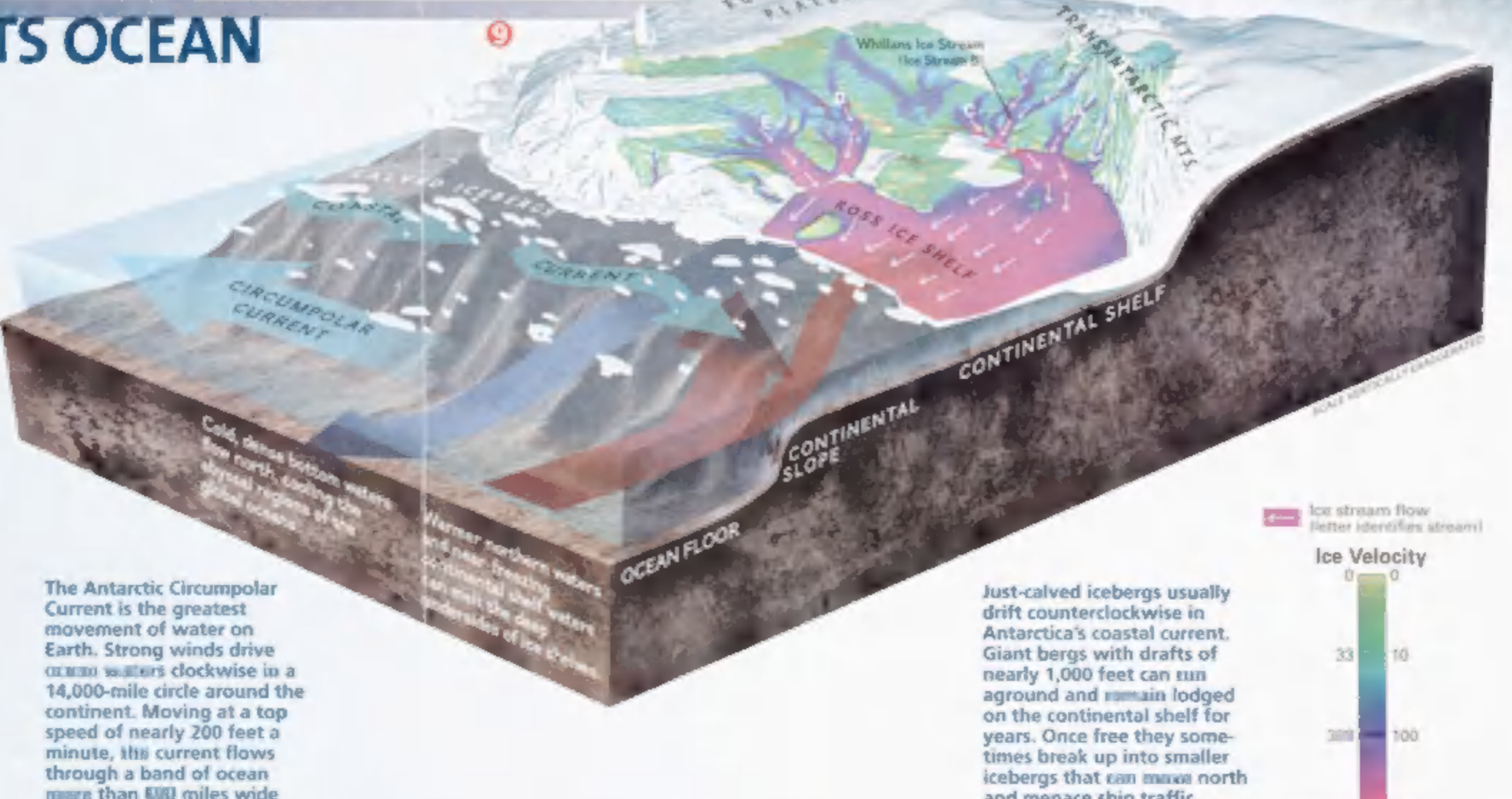
**12** CONTINENTAL SHELVES Antarctica's continental shelves lie under an average of 1,300 feet of ice—three times deeper than the mean shelf depth elsewhere in the world. Glaciers and sediments deposited record the advance and retreat of coastal glacier tongues.



**13** FOSSIL DISCOVERIES reveal a warmer, greener Antarctic past. *Cryolophosaurus*, a carnivorous dinosaur (above) lived some 200 million years ago in what are now the Transantarctic Mountains. A hundred million years later riverborne sediments buried a tree on the Antarctic Peninsula. Its petrified remains (right), still stand on Alexander Island.

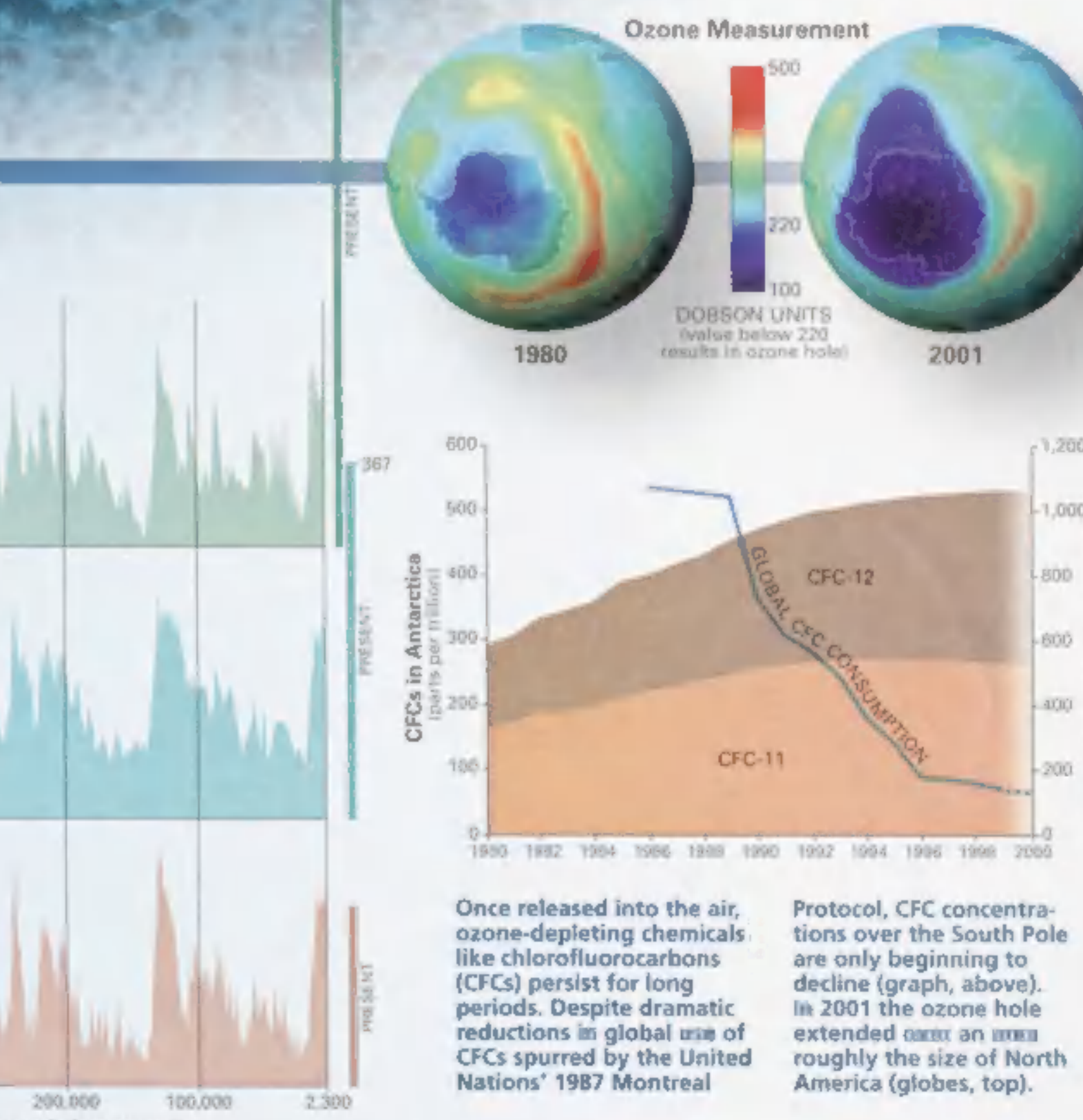
### WHERE ICE MEETS OCEAN

Antarctica's ice sheet and surrounding oceans form a kind of giant conveyor belt. Moisture from the oceans falls on the continent as snow. Centuries of pressure and cold turn snow into ice, which moves—at first imperceptibly slowly, then gaining speed—down the long curves of the ice sheet. Complex systems of tributary glaciers flow into enormous riverlike ice streams (white arrows on glaciers, right), some of which move up to a mile and a half a year. Fed by this network of ice streams, ice shelves grow past the grounding line—the last contact point between ice and bedrock—and spread a thick layer of floating ice over the ocean. Ice turns to water again as warm ocean currents melt the underside of ice shelves and as shelf edges calve icebergs into the sea. Most experts think this ice-ocean system is near equilibrium, with ice accumulation balancing ice shelf losses by melting and iceberg calving. Climate warming could shift the balance, however, and accelerated melting could raise sea level worldwide.



### ATMOSPHERE ARCHIVE

As each year's snow accumulates, particles of dust and atmospheric chemicals and minute bubbles of air are trapped among the flakes, inscribing a detailed annual climate log in the Antarctic ice. Ice cores—vertical samples drilled from the ice sheet—allow scientists to read this archive. Almost 12,000 feet long, the ice core collected near Russia's Vostok Station records 420,000 years of climate data (graphs, right), including temperature and atmospheric concentration of the greenhouse gases carbon dioxide and methane. It shows repeated cycles of climate change, with greenhouse gases contributing significantly to the warming in each 100,000-year cycle. It also puts current carbon dioxide and methane levels in context: Driven by human activities—especially the burning of fossil fuels—concentrations of greenhouse gases are higher now than at any time in almost a half million years.



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**MAP SUPPLEMENT: ANTARCTICA**

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BY CARSTEN PETER

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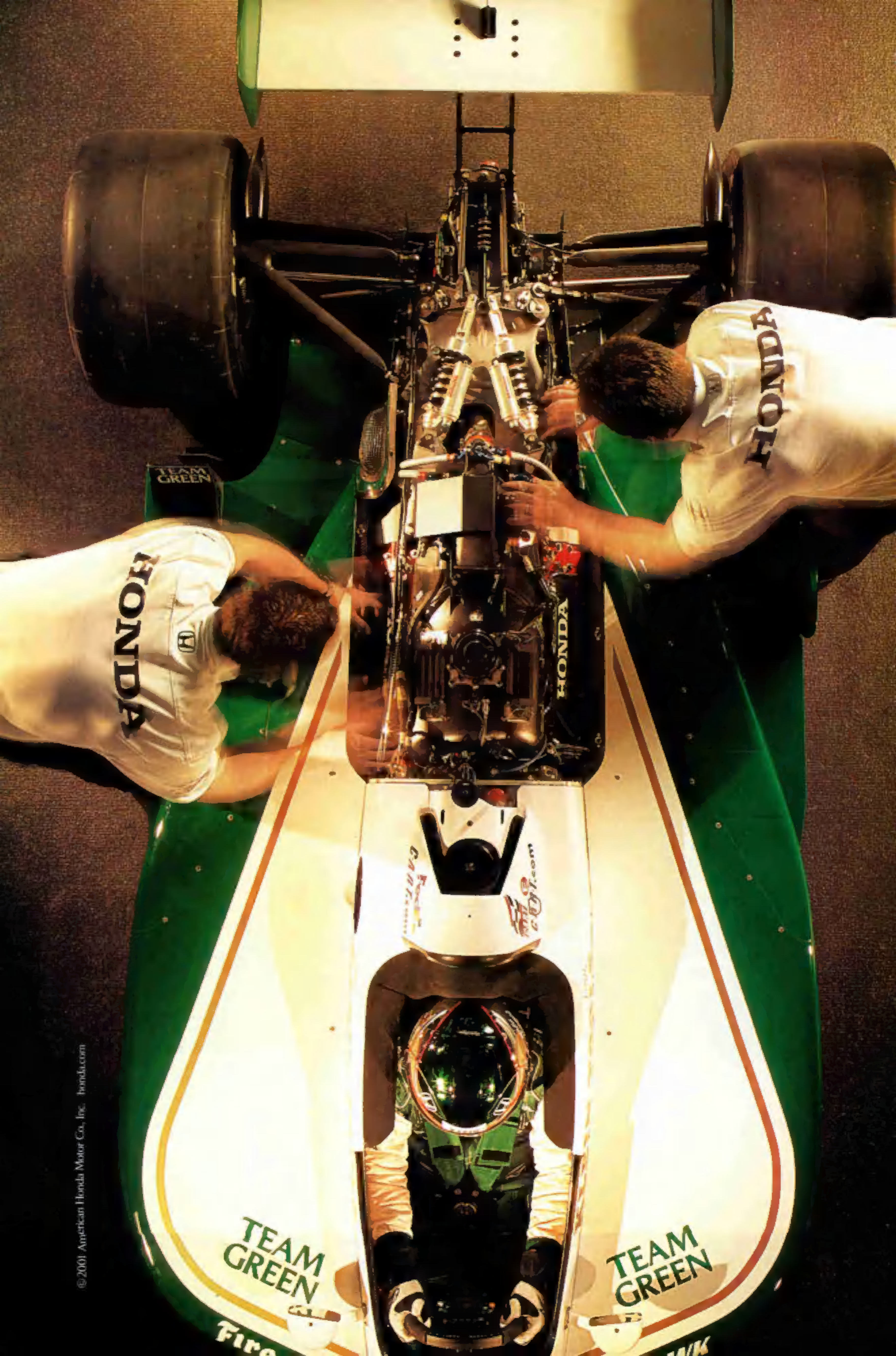
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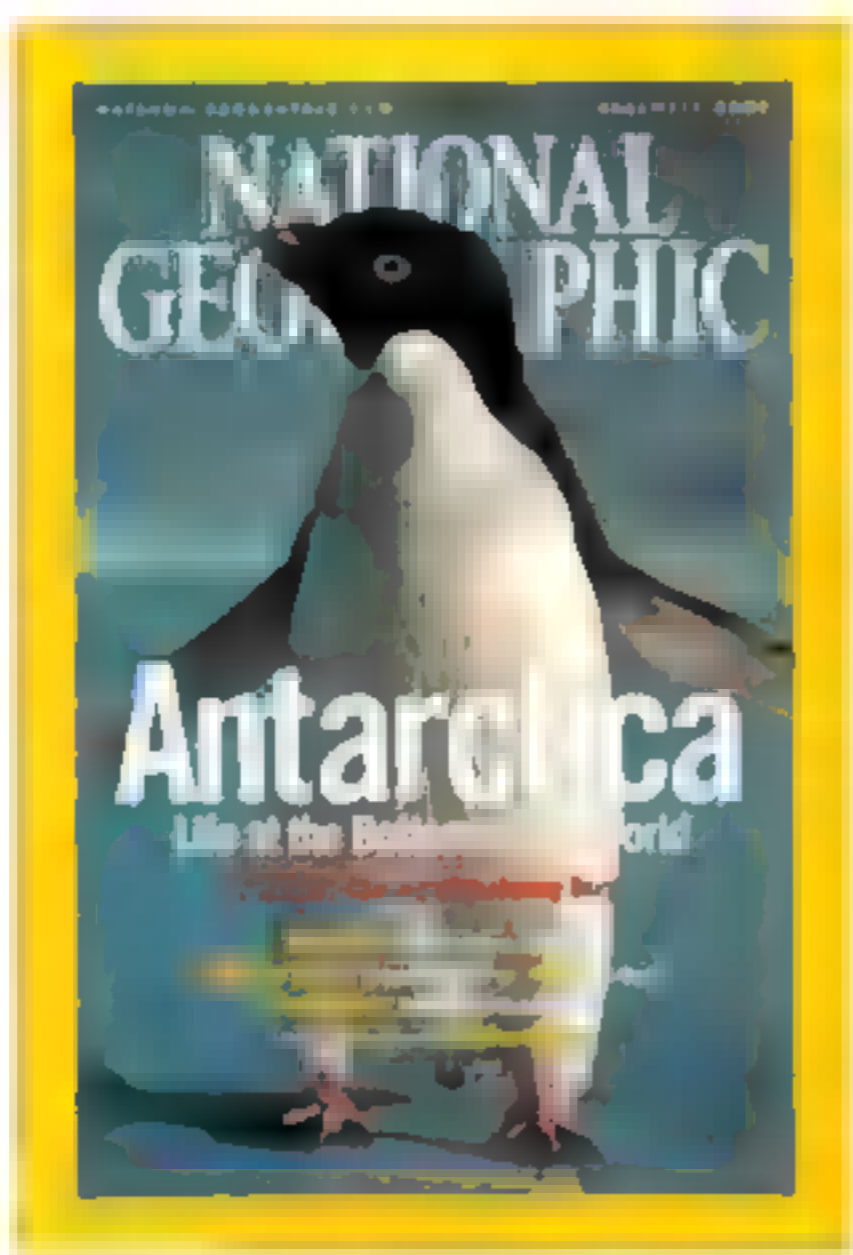
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# From the Editor



COVER PHOTO BY ROBERT STENZEL

**D**oes this little bird look lost? Maybe it's because we abandoned him. Late last summer we were planning a map supplement to accompany our December 2001 Antarctica story. I'd already picked this cover of an adult Adélie penguin on Cape Crozier for the December issue.

Then came September 11.

In a matter of days December's penguin was replaced by a cover story on Abraham, chosen to give background on the common heritage of Judaism, Christianity, and Islam. For that same issue our National Geographic Maps staff produced, in record time, a new supplement on Afghanistan and Pakistan. We've since distributed 50,000 copies of this map free to teachers through our state geographic alliances.

We also revised last month's issue, and this one, to keep you informed about the places in the news. Often our experts are just down the hall. Last month's "World of Islam" was the work of Senior Editor Don Belt, author of four previous articles on the Middle East for the magazine. And this month Assistant Editor Mike Edwards, in "Central Asia Unveiled," mines decades of experience reporting on the countries he first saw as a Peace Corps program officer 36 years ago.

Our schedule has settled down for now, but please do yourself and me a favor. Go find your December GEOGRAPHIC and reread the story on Antarctica, now that you've got the map—and the penguin—to go with it.

*Bill Allen*

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# Forum

## October 2001

"The Power of Light" generated comments on science, religion, and even a "boorish and inconsiderate" neighbor's floodlights. The article on Southeast Asia's rain forests inspired more lighthearted responses. One reader remarked on the picture on pages 32-3: "I love the photo taken by Tim Laman of the cute little critter that looks like a gremlin munching on a cockroach. We should all be so content."



## Tracking the Leopard

I am dismayed that you grouped sport hunters with poachers as threats to big cats. Sport hunters are responsible for financing surveys on which licensing is based, and licensing serves to keep wildlife within critical limits of food and water. Hunters assist in enforcing game laws and have been used by researchers to report illegal hunting and poaching. They also help people of the bush understand the funds available through proper management of the resources around them. Please do not group such wildlife conservationists, who are loyal to the cause, with the poacher who indiscriminately slaughters for profit.

LOWELL C. DOUGLAS  
Duluth, Georgia

I was thrilled to see Tjololo on the cover, since I have watched him on *africam.com*. I do believe, however, that the picture of the leopard with the impala kill on pages 98-9 is not Tjololo. You can tell by the markings between

the eyes and his ears. Tjololo has beautiful dots and his ears are a bit tattered.

CAROLE BRUNSON  
Tampa, Florida

Tjololo is indeed the leopard shown on pages 98-9. The pattern of dots between his eyes is not clear in this side view, but it is there. Kim Wolhuter photographed Tjololo for several years, during which the cat's ears were nicked and torn in fights with prey and other leopards. This picture was taken before Tjololo's ears were notched.

I think a lot of people would like to know how Kim Wolhuter got Tjololo to accept his company, since leopards are loners and territorial animals.

JAMES J. COOK  
Middletown, New Jersey

Kim Wolhuter responds: Basically I hung around and followed Tjololo until he just accepted me as part of the landscape. He did the same with a hyena that constantly followed him.

## Rain Forest Night

In your article on the rain forests of Southeast Asia you refer to the lack of political means or will to stop illegal logging in the



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**Power of Light**

I am haunted by Joe McNally's image on pages 30-31 [right]. I couldn't take my eyes off the hazy silhouette of the World Trade Center's Twin Towers in the background. Who would have thought that background would be so dramatically altered from the time you produced this issue to the time I received it in my mailbox? And who would have thought that a photo of a man changing a lightbulb could make me cry?

HOLLEY ARVESEN  
San Ramon, California

As I read about Luxor Resort and Casino's practice of lighting up space at the cost of 273,000 watts per hour, I see the efforts of countless

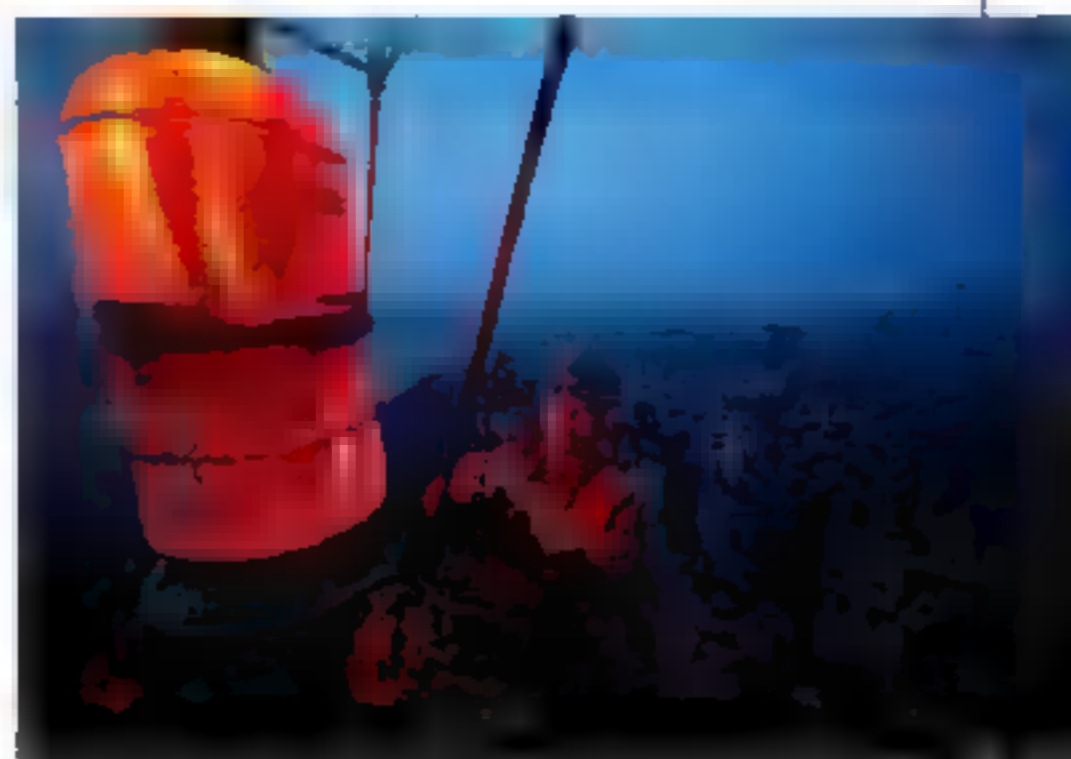
conscientious people—those who are doing their share to conserve some of our planet's finite resources—being effectively neutralized.

RICHARD GRANGER  
New Providence, New Jersey

On page 23 you explain why distant mountains appear blue. Leonardo da Vinci advised: "Paint five times bluer what you want to be five times farther." Indeed, in the greatest masters, like Brueghel, the deepest parts of a landscape are a brilliant blue.

UGO BESSI  
Rome, Italy

You did not mention a great contributor to the development of light, Nikola Tesla. He designed and wrote of countless



uses of light, including communication and national defense devices. When presented with the Edison Medal in 1917, he was introduced as the "Master of Lightning." However, of all his awards, which he received from all over the world, it was his certificate of U.S. citizenship that he treasured most. This he kept in a locked fireproof safe.

THOMAS C. MCCORT  
Morristown, Ohio

area. I would like to draw your attention to an optimistic piece of progress. In September representatives of all regional governments (excluding Malaysia because it does not acknowledge the extent of illegal logging), nongovernmental organizations, forestry experts, the World Bank, and the G8 nations met in Bali, Indonesia, to try to tackle the crisis. They issued a landmark declaration including provisions to prevent movement of illegal timber, raise consumer awareness, and enable governments and societies to "prevent, detect, and suppress forest crime." This is a hopeful indication that the

devastation in the region is at last being taken seriously.

ALICE HACKETT  
London, England

**Treasures of Ancient China**

"Rising to Life" was colorful and informative. I have been to Xian and had a tour of the site and its museum. Qin Shi Huang Di was a tyrant. He enslaved workers, and many of them died. The terra-cotta warriors were created at a horrific cost to humanity.

ALLEN COATES  
Orange Park, Florida

When visiting the site, we were surprised to see how tall the warriors were. If they were "life-size," then the average Chinese man as depicted in Hongnian Zhang's illustration on page 54 would have been over six feet tall.

JAN-DIRK AND RITSUKO  
WAGENAAR  
Salamanca, Spain

Figures from Pit 1 are about five and a half to six feet tall—a plausible range for northern Chinese soldiers then and now. But "life-size" does not imply exact realism; officers, for example, were always portrayed as taller than ordinary soldiers, whatever the height of the living models.

Thank you for your splendid coverage of the sites being excavated in Xian, China. The caption on page 59 describes two tablets as "board games similar to chess." I suggest the possibility that you have depicted a board used to play *weiqi*, known in Japan and in the West as *go*. In ancient China *weiqi* was considered an art form and was an accomplishment required of a nobleman. It would have been an integral part of the lighter side of court life.

ROY LAIRD  
President, American Go Association  
New York, New York

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*Board games of strategy were certainly important at the Qin and Han courts, but literary sources link these tablets to liubo, another such game. It was thought to be played by the immortals as well as humans and may have included an element of divination.*

You gave several possible reasons for the face of the mystery soldier to be painted green. It may be that terra-cotta images were painted green to make them look like bronzes, which develop a green patina and were of high importance in ancient China. In antiquity ceramic objects were sometimes decorated to look like another material.

JAMES F. NEWELL  
Big Bear City, California

*The Qin valued bronzes, but they kept them highly polished. Antique bronzes that had turned green over time were not collected and prized until much later.*

### Swahili Coast

Zanzibar is an incredible island. The tolerance between different ethnic groups and religions is unique. But the way you described and pictured Zanzibar is too romantic. The poverty and sickness I witnessed in 1997 are nowhere mentioned. Often the change in my pocket was worth two or three daily salaries, and I am a middle-class citizen of a rather poor country.

GORAN PALADIN  
Zagreb, Croatia

I just returned from a wonderful holiday in Zanzibar. Your article brought it to life so well that I felt as if I was still there. The people are so warm and tolerant. I was in Zanzibar when we heard the terrible news about the attacks on the United States. The Zanzibaris were as shocked and distressed at the news as

**The way you described and pictured Zanzibar is too romantic. . . . The change in my pocket was worth two or three daily salaries, and I am a middle-class citizen of a rather poor country.**

we were. Africa is a wonderful and compelling continent and will continue to call me back at regular intervals. I hope the Western world will wake up to the immense problems these wonderful people encounter with great fortitude and cheerfulness.

RHODA SWAN  
Lindlithgow, Scotland

Why was the Portuguese occupation of Zanzibar summarily dismissed as "brutal"? In the late 15th century Portuguese ships entered the Indian Ocean and Arabian Sea. Fighting ensued because Arab-ruled states in Africa and western India naturally wanted to keep their monopoly on trade. What did the U.S. do when North Africans harassed their shipping in the early 19th century? They sent their frigates. That was what Portugal did, as well as erecting fortified outposts to protect its anchorages.

MANUEL C. CERQUEIRA  
Lisbon, Portugal

### California's Volcanic North

I was surprised and overjoyed to read your article on northern

California's volcanoes. Your descriptions of the terrain and the pragmatic people were accurate, but no mention was given to a recent decision by the United States Bureau of Reclamation to cut vital water supplies to wildlife refuges and farmlands of the Klamath Basin. It is of little relevance in geologic time, but it threatens the agricultural way of life in this isolated area.

STUART MILES  
Charleston, South Carolina

*In 2001, a year of severe drought, the bureau temporarily interrupted some allotments for irrigation and refuges in order to maintain the stream flow and lake levels required to protect several endangered fish species.*

### Geographica

Jim Hellemn's life-size photographic mural of Bloody Bay Wall is simply drop-jaw stunning. It is also a tremendously powerful monitoring tool for marine ecologists. The last sentence reads, "Perhaps marine biologists studying coral reefs around the world will take note." Marine ecologists have studied coral reef dynamics for decades using sequential photographs obtained with a quadrapod. Using a quadrapod, a diver can take several high-resolution color photos of a known dimension, thereby recording community changes over time. But Hellemn's technique has raised the bar several notches.

JAMES A. COYER  
Department of Marine Biology  
University of Groningen,  
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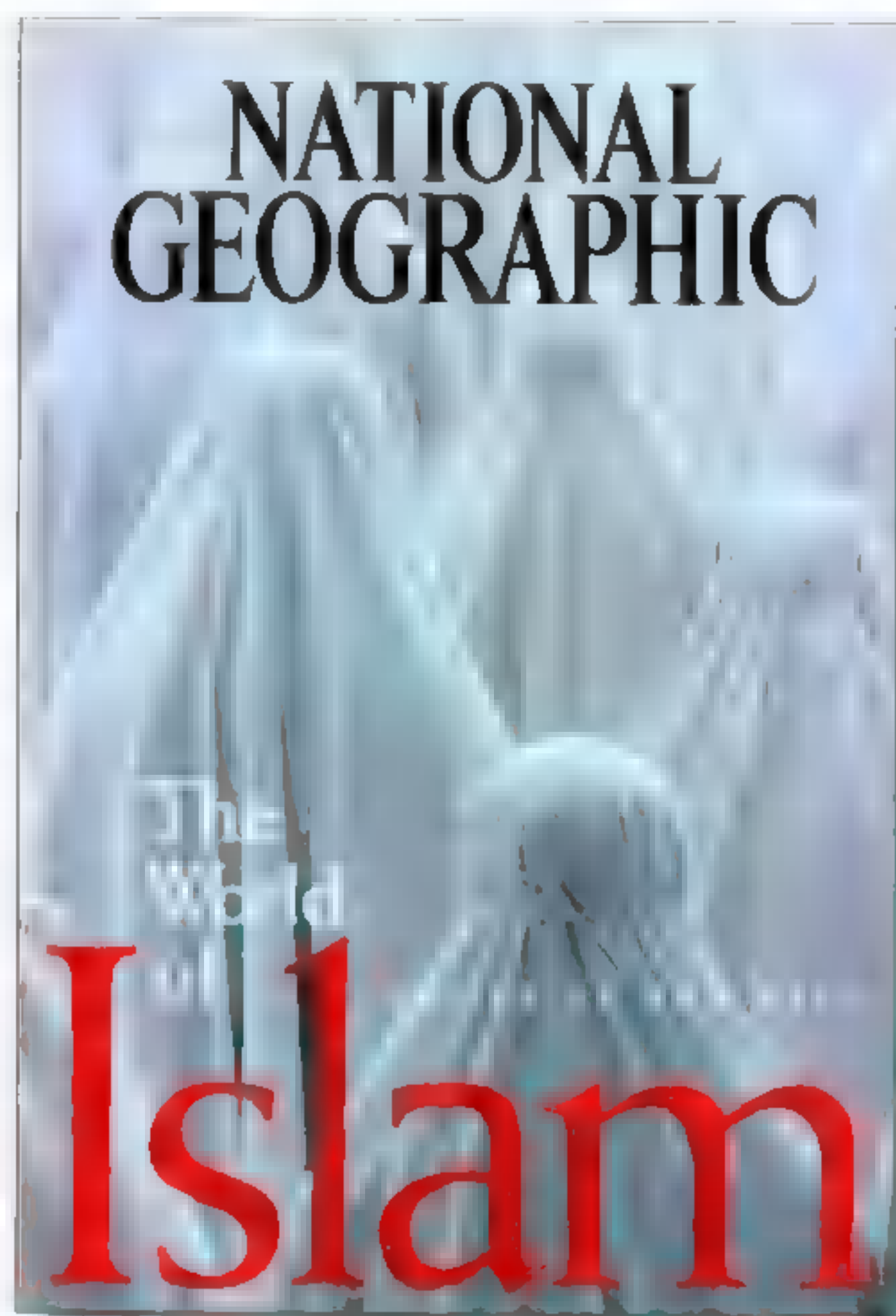
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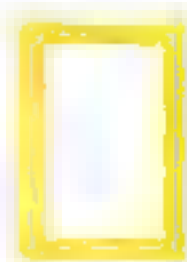


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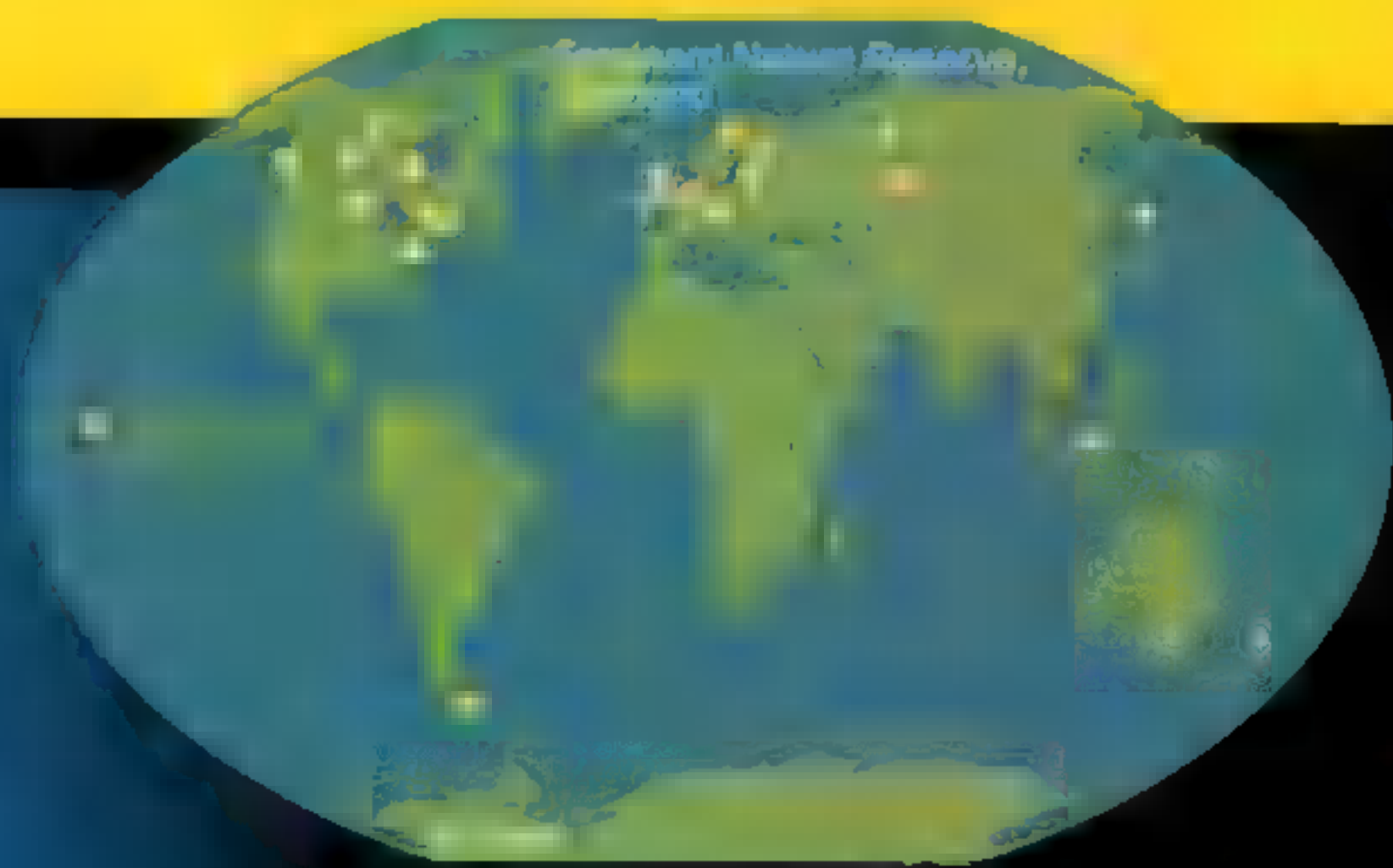
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These peatland ponds in northern Scotland lie near Fochassan Nature Reserve, run by the Royal Society for the Protection of Birds. The bogs here are restored blanket bogs because the peat blankets the hillsides as well as flat areas.

According to reserve manager Norrie Russell, some 5,000 people a year come to see black-throated divers (a loon species), black scoter ducks, and insects like the spectacular cup-shaped moth (below).

Twenty years ago foresters began draining the bogs, polluting them with fertilizers and planting trees, which had been absent. The acidity is now turning 4,000 forested acres back into peatland.

Raised bogs—a different type, which grows in a dune above its original depression—have been harvested commercially for decades to provide peat for gardens and hearths.

#### MORE ON OUR WEBSITE

For a listing of resources and links related to bogs go to [nationalgeographic.com/ngm/0202](http://nationalgeographic.com/ngm/0202).

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ADRIAN DAVIES (ABOVE) AND [NAME] HALLETT, BBC NATURAL HISTORY UNIT

# GEOGR

THE PEOPLE, PLACES, AND

ARCHAEOLOGY

## Who Killed the Iceman?

*New find raises questions about prehistoric mummy*



A moistening spray mists the 5,000-year-old Iceman mummy at the South Tyrol Museum of Archaeology in Bolzano, Italy.

**H**e came along 5,000 years ago in a mummy's slipper on the Austro-Italian border before passing. Hunters discovered him, mired in the mountain snow, in 1991. He now resides in a refrigerated room at a museum in Italy. Over

the 11 years since his discovery, the Iceman mummy has been examined from every possible angle. But not until this past summer did three studies of his still frozen body reveal a crucial piece of evidence that dramatically rewrites his story: "Ötzi,"

nicknamed for the Ötztal Alps where he was found, didn't freeze to death in a sudden snow storm. He likely had a violent death, since he'd suffered a wound that was lethal, a victim of warfare, murder or human sacrifice.

They reveal an arrowhead



# APHICA

PHOTOGRAPH BY

UNIVERSE



EDUARD EGARTER VIGL, LANDSAT, IMAGE © ESA 2001, DISTRIBUTED BY EURONAV

Several deep in the Iceman's left shoulder—a injury that could not initially have been self-inflicted (see accompanying page, center left). The wound, visible as a small dark smudge beneath the mummy's leathery skin (bottom left), had been made

in all probability with a sharp arrowhead. Although no arrow shaft protrudes from the wound and no blood marks the arrow's entrance, it's now clear that the Iceman was shot in the back. But who did it? And how?  
“There’s no way anyone here

could have done it,” says archaeologist Stuart Burdley, a British Academy research fellow. “It might have been murder. Or it might have been ritual sacrifice.”

Burdley knows mummies. Among the many he has discovered is the famous “ice mummy,” a victim of hypoxia on the frozen slopes of Peru’s Nevado Annapurna in 1995. His expertise studying ancient cultures in the Andes, the Himalaya, and elsewhere has convinced him that the Iceman’s death was no accident.

“Look at where he died,” Burdley says (map, above). “It’s a prominent pass between two of the highest peaks in the Central Alps. This is the kind of place where people from mountain cultures have traditionally made pilgrimages to their mountain gods. We have that mountain worship was important in prehistoric Europe during the Bronze Age,” he says. “And there is good evidence that it may also have played a role earlier, in the Copper Age.”

**"ALONG WITH ALL THE GREAT MEMORIES HAS COME  
SOMETHING I THOUGHT I'D NEVER EXPERIENCE—  
THE PAIN OF OSTEOARTHRITIS."**

**—DOROTHY HAMILL**



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- had a serious stomach problem in the past.

Tell your doctor about:

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- all medicines that you are taking or plan to take, even those you can get without a prescription.

Tell your doctor if you develop:

- ulcer or bleeding symptoms (for instance, stomach burning or black stools, which are signs of possible stomach bleeding).
- unexplained weight gain or swelling of the feet and/or legs.
- skin rash or allergic reactions. If you have a severe allergic reaction, get medical help right away.

#### How should I take VIOXX?

VIOXX should be taken once a day. Your doctor will decide what dose of VIOXX you should take and how long you should take it. You may take VIOXX with or without food.

#### Can I take VIOXX with other medicines?

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- rifampin (an antibiotic)
- ACE inhibitors (medicines used for high blood pressure and heart failure)
- lithium (a medicine used to treat a certain type of depression).

#### What are the possible side effects of VIOXX?

Serious but rare side effects that have been reported in patients taking VIOXX and/or related medicines have included:

- Serious stomach problems, such as stomach and intestinal bleeding, can occur with or without warning symptoms. These problems, if severe, could lead to hospitalization or death. Although this happens rarely, you should watch for signs that you may have this serious side effect and tell your doctor right away.
- Serious allergic reactions including swelling of the face, lips, tongue, and/or throat which may cause difficulty breathing or swallowing and wheezing occur rarely but may require treatment right away. Severe skin reactions have also been reported.
- Serious kidney problems occur rarely, including acute kidney failure and worsening of chronic kidney failure.
- Severe liver problems, including hepatitis, jaundice and liver failure, occur rarely in patients taking NSAIDs, including VIOXX. Tell your doctor if you develop symptoms of liver problems. These include nausea, tiredness, itching, tenderness in the right upper abdomen, and flu-like symptoms.

In addition, the following side effects have been reported: anxiety, confusion, depression, hair loss, hallucinations, increased levels of potassium in the blood, low blood cell counts, palpitations, pancreatitis, tingling sensation, unusual headache with stiff neck (aseptic meningitis), vertigo.

More common, but less serious side effects reported with VIOXX have included the following:

Upper and/or lower respiratory infection and/or inflammation  
 Headache  
 Dizziness  
 Diarrhea  
 Nausea and/or vomiting  
 Heartburn, stomach pain and upset  
 Swelling of the legs and/or feet  
 High blood pressure  
 Back pain  
 Tiredness  
 Urinary tract infection.

These side effects were reported in at least 2% of osteoarthritis patients receiving daily doses of VIOXX 12.5 mg to 25 mg in clinical studies.

The side effects described above do not include all of the side effects reported with VIOXX. Do not rely on this leaflet alone for information about side effects. Your doctor or pharmacist can discuss with you a more complete list of side effects. Any time you have a medical problem you think may be related to VIOXX, talk to your doctor.

#### What else can I do to help manage my osteoarthritis pain?

Talk to your doctor about:

- Exercise
- Controlling your weight
- Hot and cold treatments
- Using support devices.

#### What else should I know about VIOXX?

This leaflet provides a summary of certain information about VIOXX. If you have any questions or concerns about VIOXX, osteoarthritis or pain, talk to your health professional. Your pharmacist can give you an additional leaflet that is written for health professionals.

Do not share VIOXX with anyone else; it was prescribed only for you. It should be taken only for the condition for which it was prescribed.

Keep VIOXX and all medicines out of the reach of children.

Inactive Ingredients:

Oral suspension: citric acid (monohydrate), sodium citrate (dihydrate), sorbitol solution, strawberry flavor, xanthan gum, sodium methylparaben, sodium propylparaben.

Tablets: croscarmellose sodium, hydroxypropyl cellulose, lactose, magnesium stearate, microcrystalline cellulose, and yellow ferric oxide.

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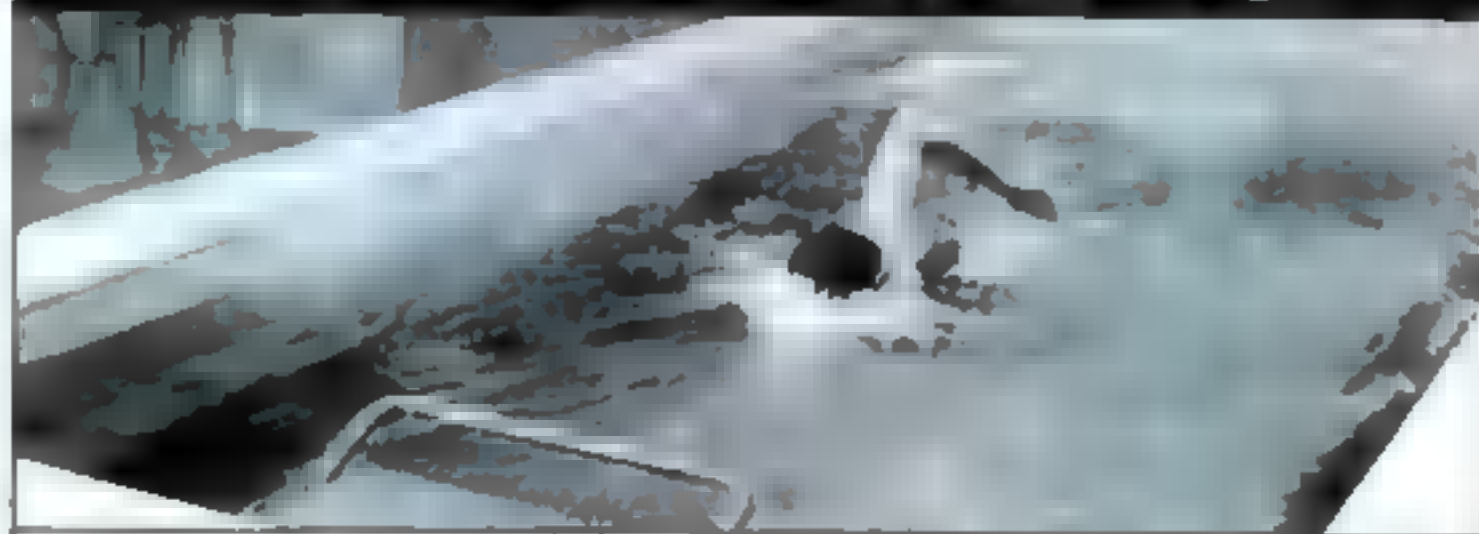
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Reinhard's interpretations seems to answer questions about artifacts found with the mummy that have long puzzled experts. For example, tracking the arrow was a ceremonial practice in Neolithic Europe. This might explain the broken arrows found near the mummy. The Iceman's copper ax (middle right)—the oldest prehistoric ax in Europe—has its head and handle intact—is also significant. Its copper had to have been mined and transported as the source of valuable metals used to make tools. "We've developed hypotheses throughout the world," says Reinhard. "This helps explain why the mummy was left with the bow after the killing." Murderers would likely have taken something as useful



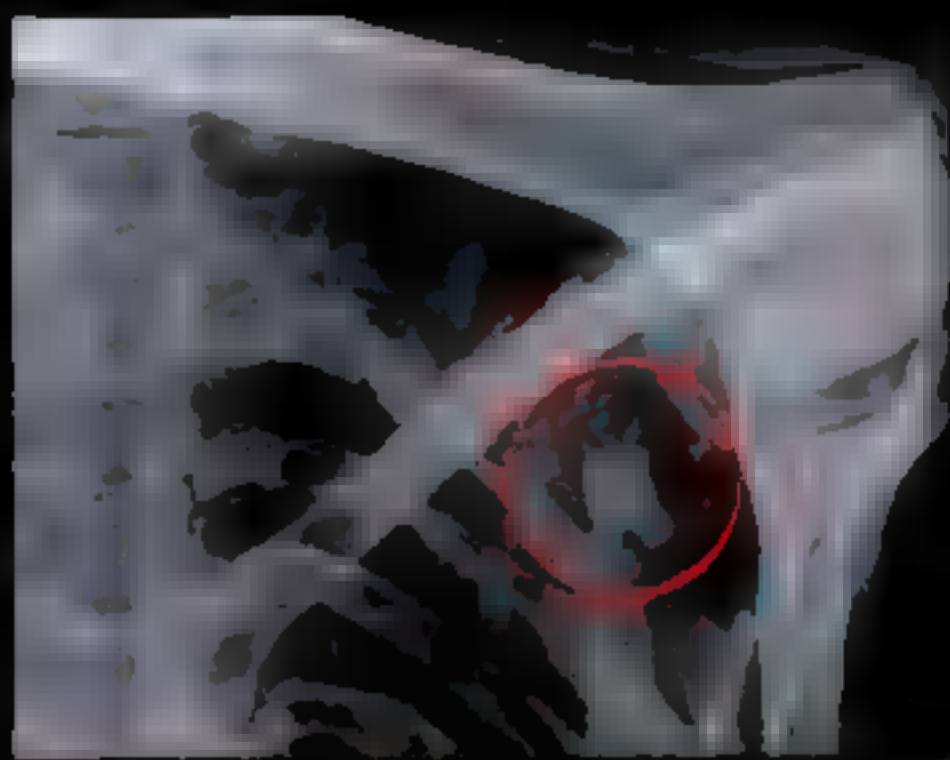
KENNETH GARRETT (ABOVE AND BELOW)

with them. But people performing a ritual might have left it for the Iceman's use in the afterlife or as tribute to the gods.

Another clue: The Iceman's body was found in a naturally formed trench along the pass. Prior explanations had him taking shelter there from sudden bad weather. "But the trench is not the best is at a high point of the pass [above]. It would have been a poor place to sit out a storm," explains Reinhard. Perhaps, instead, the Iceman was buried there by whoever killed him, which would

account for his body's being so well preserved.

Reinhard's ideas have not been met with enthusiasm by European experts, including the mummy's caretaker, pathologist Eduard Egarter Vigl of the South Tyrol Museum of Archaeology. "The Iceman was hit by an arrow



PAUL GOSTNER, SOUTH TYROL MUSEUM OF ARCHAEOLOGY



from behind," he says, suggesting that Otto may have been fleeing from an attacker. Ottens maintains that arrows aren't efficient means of ritual killing and that no clear evidence of any other groups. Age sacrifice exists.

"They view the idea of human sacrifice as too sensational," says Reinhard. "But they can't tell me what I've pointed out, and I believe my theory better explains the known facts."

"I know it's controversial," he admits. "But it's time to reexamine the evidence from a different perspective. Let's look at these artifacts not only relative to each other but also within ritual, sacred, and ceremonial contexts."

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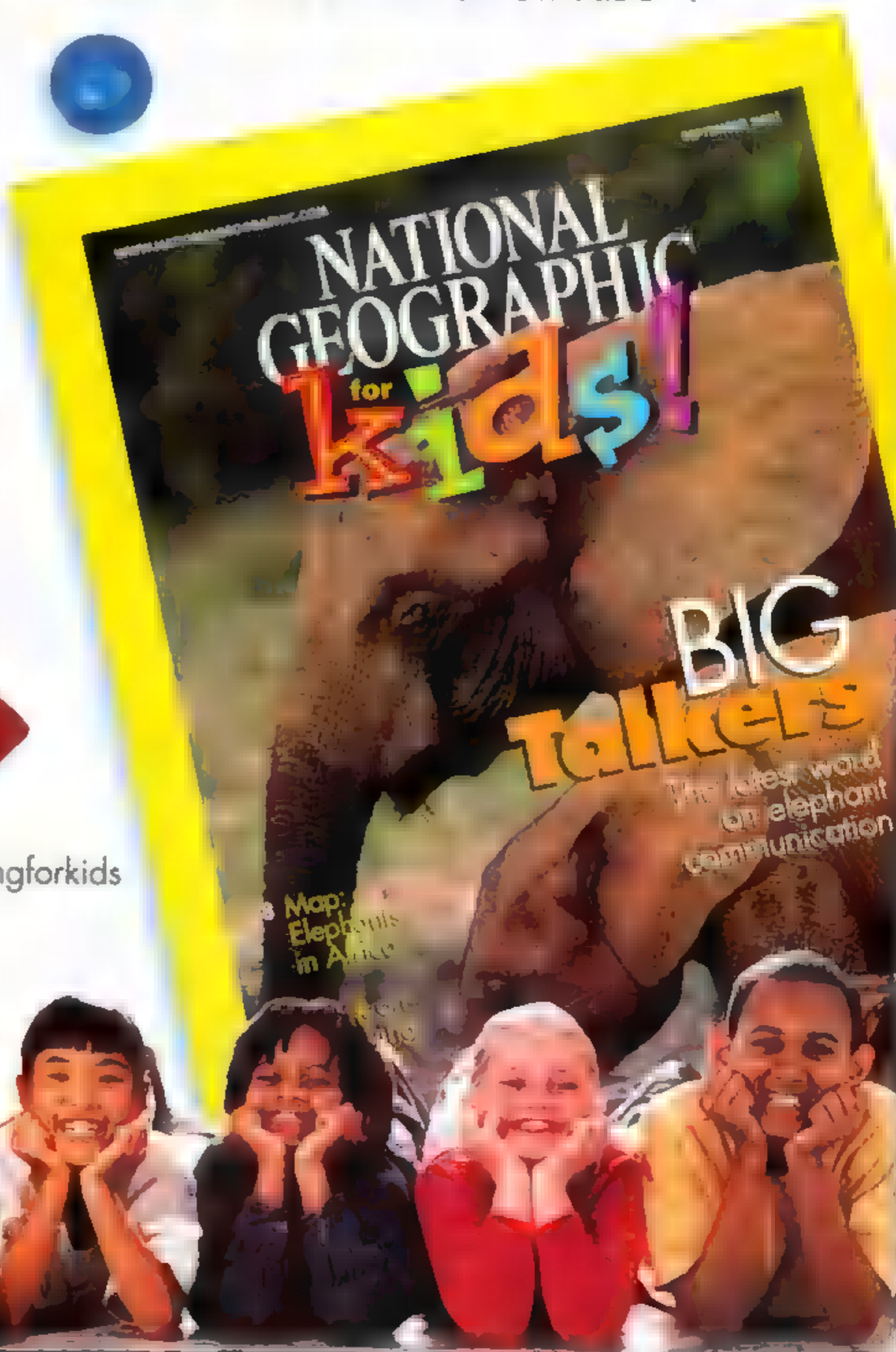
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# Behind the SCENES

AT THE NATIONAL GEOGRAPHIC SOCIETY



MICHELE TAYLOR

## Flocking to New Sights

*Geographic newsletter helps birders stay focused*

**A**re you, like these people at Mrazek Pond in Florida's Everglades National Park, one of the 63 million Americans who

passionately search for and photograph birds? If so, you now have a new perch: *National Geographic Bird Watcher*. A subscription (\$24 a year;

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VICTORIA TOENSING

## The Lady in the Yellow Hat

*Maine islanders warmed by photo exhibit*

**A**my Toensing made many friends while photographing Monhegan Island, Maine, for last July's article about the island and its residents. She repaid their friendship with an exhibit of 25 of her Monhegan photographs at the island's museum. One of the first people she saw when she arrived for the exhibit's July opening was Frances Kornbluth, an artist and longtime summer

resident whose dour expression in the article's opening spread embodied the island's ambivalence about visitors. "It was raining," Amy recalls. "There was Frances in the same outfit she had on in the article, the whole nine yards. She said, 'Amy, the pictures are beautiful!'" The exhibit stayed on Monhegan until October, then traveled to other Maine locations, including the governor's mansion in Augusta.

## Provence, Texas?

While in Provence to photograph lavender for our October 1998 perfume article, Robb Kendrick realized that the French region's hot, dry climate and alkaline soil were similar to the Texas Hill Country. He planted lavender on his 225-acre spread there and harvests it with help from his wife, Jeannie, and sons, Gus and Jeb. Buyers use lavender as an herb and in floral arrangements. "It doesn't need water or fertilizer, and deer don't like it," Robb says. "The only thing it lacks is the ability to harvest itself."



ROBB KENDRICK AND SON, AMZOLIAN, STATE SMAN



NATIONAL GEOGRAPHIC PHOTOGRAPHER MARK THRENDY

## Keepers of the Flame

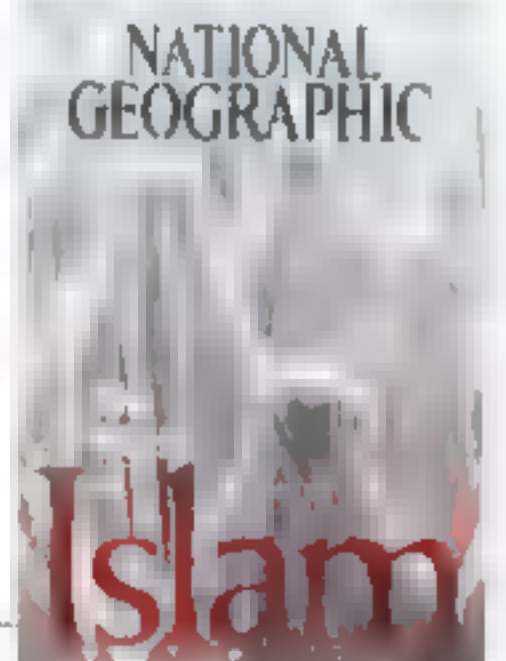
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In 1995 we published a magazine series, "The Afghan Borderland"—the first, but far from the last, appearance of that troubled land in our magazine, according to a time line prepared by Society staff archivist Mark Jenkins. That sample of Geographic history and other records of adventure, exploration, and science typify the

holdings of our archives, created by Peter Braden (above, at right, with Mark and Cathy Hunter). The archives contain manuscript and memorabilia collections, the papers of past editors and Society officials, and oral histories and biographies. Local and international staff rely on this valuable record of the past to inform our future.

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For people with type 2 diabetes

## “By taking care of my diabetes, I take care of my family.”

“I’ve made the commitment for myself, but it’s also for my family. For my wife and my two beautiful daughters – they’re everything to me. All I have to do is look at them, any one of them, and I find all the strength, all the reason, all the determination I need to take better care of myself.

“I was eating better, exercising more. But that still wasn’t enough. So my doctor added *Avandia*. It makes my body more responsive to its own natural insulin, so I can control my blood sugar more effectively.

“So finally, with the help of *Avandia*, I’m controlling my type 2 diabetes, instead of the other way around. And while not everybody gets the same results, I’ve been able to keep my blood sugar down for just about a year now. That’s the strength of doing things right.”

*Avandia*, along with diet and exercise, helps improve blood sugar control. ■ may be prescribed alone, with Glucophage® (metformin HCl tablets) or with sulfonylureas. When taking *Avandia* with a sulfonylurea, you may be at risk for low blood sugar. Ask your doctor whether you need to lower your sulfonylurea dosage.

Some people may experience tiredness, weight gain or swelling with *Avandia*.

*Avandia* in combination with insulin may increase the risk of serious heart problems. Because of this, talk to your doctor before using *Avandia* and insulin together. *Avandia* may cause fluid retention, or swelling, which could lead to or worsen heart failure, so tell your doctor if you have a history of these conditions. If you experience an unusually rapid increase in weight, swelling or shortness of breath while taking *Avandia*, talk to your doctor immediately. *Avandia* is not for everyone. If you have severe heart failure or active liver disease, *Avandia* is not recommended.

Also, blood tests to check for serious liver problems should be conducted before and during *Avandia* therapy. Tell your doctor if you have liver disease, or if you experience unexplained tiredness, stomach problems, dark urine or yellowing of the skin while taking *Avandia*. See important patient information on the following page.

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## Patient Information about **AVANDIA® (rosiglitazone maleate)** 2 mg, 4 mg, and 8 mg Tablets

### What is *Avandia*?

*Avandia* is one product in a class of prescription drugs called thiazolidinediones (thigh-a-zol-a-deen-die-owns) or TZDs. It is used to treat type 2 diabetes by helping the body use the insulin that it is already making. *Avandia* comes as pills that can be taken either once a day or twice a day to help improve blood sugar levels.

### How does *Avandia* treat type 2 diabetes?

If you have type 2 diabetes, your body probably still produces insulin but it is not able to use the insulin efficiently. Insulin is needed to allow sugar to be carried from the bloodstream into many cells of the body for energy. If insulin is not being used correctly, sugar does not enter the cells very well and builds up in the blood. If not controlled, the high blood sugar level can lead to serious medical problems, including kidney damage, blindness and amputation.

*Avandia* helps your body use insulin by making the cells more sensitive to insulin so that the sugar can enter the cell.

### How quickly will *Avandia* begin to work?

*Avandia* begins to reduce blood sugar levels within 2 weeks. However, since *Avandia* works to address an important underlying cause of type 2 diabetes, insulin resistance, it may take 8 to 12 weeks to see the full effect. If you do not respond adequately to your starting dose of *Avandia*, your physician may increase your daily dose to improve your blood sugar control.

### How should I take *Avandia*?

Your doctor may tell you to take *Avandia* once a day or twice a day (in the morning and evening). It can be taken with or without meals. Food does not affect how *Avandia* works. To help you remember to take *Avandia*, you may want to take it at the same time every day.

### What if I miss a dose?

If your doctor has prescribed *Avandia* for use once a day:

- As soon as you remember your missed dose, take one tablet anytime during the day.
- If you forget and go a whole day without taking a dose, don't try to make it up by adding another dose on the following day. Forget about the missed dose and simply follow your normal schedule.

If your doctor has prescribed *Avandia* for use twice a day:

- As soon as you remember the missed dose, take ~~one~~ tablet.
- Take the next dose at the normal time on the same day.
- Don't try to make up a missed dose from the day before.
- You should never take three doses on any single day in order to make up for a missed dose the day before.

### Do I need to test my blood for sugar while using *Avandia*?

Yes, you should follow your doctor's instructions about your at-home testing schedule.

### Does *Avandia* cure type 2 diabetes?

Currently there is no cure for diabetes. The only way to avoid the effects of the disease is to maintain good blood sugar control by following your doctor's advice for diet, exercise, weight control, and medication. *Avandia*, alone or in combination with other antidiabetic drugs (i.e. sulfonylureas or metformin), may improve these other efforts by helping your body make better use of the insulin it already produces.

### Can I take *Avandia* with other medications?

*Avandia* has been taken safely by people using other medications, including other antidiabetic medications, birth control pills, warfarin (a blood thinner), Zantac® (ranitidine, an antiulcer product from GlaxoSmithKline), certain heart medications and some cholesterol-lowering products. You should discuss with your doctor the most appropriate plan for you. If you are taking prescription or over-the-counter products for your diabetes or for conditions other than diabetes, be sure to tell your doctor. Sometimes a patient who is taking two antidiabetic medications each day can become irritable, lightheaded or excessively tired. Tell your doctor if this occurs; your blood sugar levels may be dropping too low, and the dose of your medication may need to be reduced.

### What should I discuss with my doctor before taking *Avandia*?

*Avandia* in combination with insulin may increase the risk of serious heart problems. Because of this, talk to your doctor before using *Avandia* and insulin together. *Avandia* may cause fluid retention or swelling which could lead to or worsen heart failure, so tell your doctor if you have a history of these conditions. You should also talk to your doctor if you have liver problems, or if you are nursing, pregnant or thinking of becoming pregnant. If you are a premenopausal woman who is not ovulating, you should know that *Avandia* therapy may result in the resumption of ovulation, which may increase your chances of becoming pregnant. Therefore, you may need to consider birth control options.

### What are the possible side effects of *Avandia*?

*Avandia* was generally well tolerated in clinical trials. The most common side effects reported by people taking *Avandia* were upper respiratory infection (cold-like symptoms) and headache. As with most other diabetes medications, you may experience an increase in weight. You may also experience edema (swelling) and/or anemia (tiredness). If you experience any swelling of your extremities (e.g., legs, ankles) or tiredness, notify your doctor. Talk to your doctor immediately if you experience edema, shortness of breath, an unusually rapid increase in weight, or other symptoms of heart failure.

### Who should not use *Avandia*?

You should not take *Avandia* if you are in the later stages of heart failure or if you have active liver disease. The following people should also not take *Avandia*: People with type 1 diabetes, people who experienced yellowing of the skin with Rezulin® (troglitazone, Parke-Davis), people who are allergic to *Avandia* or any of its components and people with diabetic ketoacidosis.

### Why are laboratory tests recommended?

Your doctor may conduct blood tests to measure your blood sugar control. Blood tests to check for serious liver problems should be conducted before starting *Avandia*, every 2 months during the first year, and periodically thereafter.

It is important that you call your doctor immediately if you experience unexplained symptoms of nausea, vomiting, stomach pain, tiredness, anorexia, dark urine, or yellowing of the skin.

### How should I store *Avandia*?

*Avandia* should be stored at room temperature in a child-proof container out of the reach of children. Store *Avandia* in its original container.



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## For the Love of Animals

During Valentine's week a marathon of programs celebrates the bonds between humans and animals. One feature, *The Tale of Three Chimpanzees*, looks at how people view chimpanzees as wild animals, pets,

and pets. The show follows the fate of three chim brothers raised in a New York City home. One stays with the circus. Another lives in a family home. The youngest finds refuge in a wildlife orphanage in Zambia.



**NATIONAL GEOGRAPHIC EXPLORER, MSNBC**

## Cowboys

Ranch hands in Brazil's Pantanal wetlands don't stop at riding and roping. They wade piranha-thick waters, hunt jaguars that threaten their stock, and lead huge cattle drives to outrace seasonal floods. *Pantanal Cowboys* presents the dangerous and endangered lifestyle of those who ride Brazil's floodplains.

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# WILDLIFE AS CANON SEES IT

The foals of the Indian wild ass, or khur, are born during the rainy season, when renewed vegetation provides the best nourishment for mares. Here, a young foal, startled by a territorial stallion, escapes while its mother follows. The two form a tight unit for a year or more until the next foal is born. In September the rains end, and for nine months small groups cross the sun-baked Little Rann looking for scarce grasses and halophytes to eat. Decades ago, the Indian wild ass population fell to under 500. Though numbers have since increased, it is still vulnerable to

droughts, human disturbance, and food competition and diseases from cattle.

As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.



**Indian Wild Ass** (*Equus hemionus khur*)  
**Size:** Length of head and body, 210-220 cm; tail, 40-50 cm; shoulder height, 108-120 cm  
**Weight:** 200-240 kg  
**Habitat:** Flat salt desert (Little Rann of Kutch and surrounding areas) in India  
**Surviving number:** Estimated at 2,890-2,990

# Ask Us

## THE ANSWER PLACE

Research Correspondence staff responds to questions from curious readers.

### Q How did Great Slave Lake in Canada's Northwest Territories get its name?

A Great Slave Lake is named for a tribe of Native Americans who resided on its shores. They lived on fish and stayed close to home. To their aggressive neighbors, the Cree, they seemed servile and were called *awonak*, or slaves. Explorer Peter Pond traded with the Cree and followed their lead, using the label Slave Lake on his 1785 map, then Great Slave Lake on the 1790 version.

### Q Why would male emperor penguins elect to stand on the outer ring of a huddle?

A Each penguin takes his turn on the outside of the huddle,

but he doesn't have to brave the Antarctic winds for long. Males huddle to conserve heat during the 65 days it takes to incubate their eggs. (The females, meanwhile, are feeding far offshore.) When a penguin on the windward edge of the huddle gets cold, he peels off and moves to the leeward side of the mass, balancing his egg on his feet under a fold of skin. Eventually each penguin gets his chance to warm up in the center. Huddles cut a penguin's heat loss in half.

### Q How do smell and color affect the taste of food?

A Although the tongue's taste buds sense the basics—sweet, salt, sour, and bitter—our sense of smell, thousands of times more sensitive, brings in the subtleties. A blindfolded person with nostrils pinched will likely find it difficult to tell a sliver of apple from one of raw

potato or even onion. Little scientific research has been done on color's effects, if any, on the taste of food, but according to restaurant designers, warm tints—oranges, reds—stimulate appetite, while the opposite is true for shades of blue.

### Q What is the largest lobster ever caught?

A The biggest on record is an American lobster trapped off Nova Scotia, Canada, on February 11, 1977, that weighed 44 pounds 6 ounces and was three feet six inches long from the end of the tail fan to the tip of the large claw. It was sold to a New York restaurateur.

## MORE INFORMATION

Send questions to Ask Us, National Geographic Magazine, PO Box 96095, Washington, DC 20090-6095 or via the Internet ■ [ngsaskus@nationalgeographic.com](mailto:ngsaskus@nationalgeographic.com). Include name, address, and daytime phone number.

## TELL US

Why is a sidewalk in Beijing, China, a good place for this man to practice calligraphy? Hint: His characters could be called into question.

Think you know the answer? Go online to [nationalgeographic.com/ngm/tellus/0202](http://nationalgeographic.com/ngm/tellus/0202) and test yourself, or read it here in next month's issue.

**January answer** The wall is made of hand-rolled Cuban cigars neatly stacked and ready to be packaged at a factory in Havana.



PHOTO: YAMASHITA

# Challenges for Humanity

## A Beginning

By Jimmy Carter

**O**URS IS AN AGE of complexity, contradiction, and challenge. As we enter the 21st century, we have wealth and technology unmatched in human experience, and the fortunate few who live in the world's developed nations are almost inevitably propelled toward a future enriched by advances in computers, communication, and life sciences.

But for most of the world's people the glittering opportunities of the new century are beyond reach. There are more than six billion of us on Earth, and by 2100 we may number ten billion. Most will live in urban centers, and many are likely to live short and impoverished lives, lacking the wealth or awareness to address problems of life in crowded cities: disease, inadequate food, and unsafe water.

We face tremendous challenges as populations soar, mostly in the poorer nations, and as consumption increases in the industrialized world. We must find ways to lessen the burden on Earth's resources, and we must encourage better stewardship of the planet so that all of us live in a clean and productive environment. The decisions we make in the decades to come will affect not only all of human civilization but also the fate of thousands of species representing millions of years of evolution.

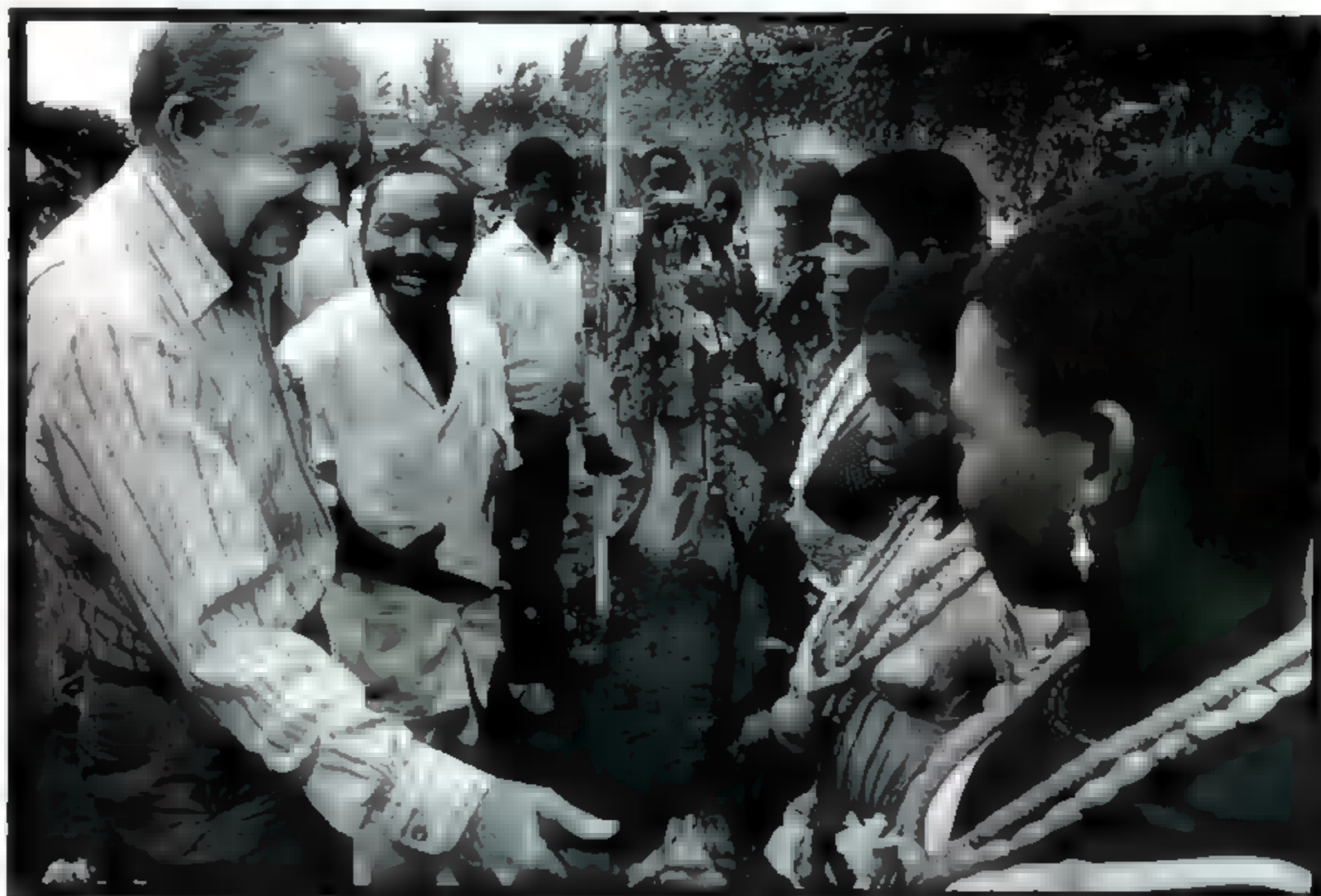
All too often our fondest expectations are frustrated. Louis Pasteur, father of the science of microbiology and a key figure in the development of vaccines in the 1880s, suggested that humans had the power "to make parasitic maladies disappear from the face of the globe." Yet since then hundreds of millions of people have died of infectious diseases—tuberculosis, malaria, AIDS, dengue, smallpox, cholera, plague, influenza, and scores of others. And after 30 years of discoveries in molecular biology—including DNA cloning, the sequencing of the human genome, and stunning new developments in techniques for human stem-cell research—we still face the daily tragedy of preventable human illnesses, some ancient and others new, unpredicted, and even more virulent.

How can we heal our planet and achieve an Earth that nurtures humanity and nature in all their diversity? As individuals we can act to reduce our risk of exposure to disease and extend care to others. As communities and as nations we can educate our citizens, legislate ethically and wisely, and support organizations that conduct research and help those who are ill.

Perhaps the most important challenge for the new century is to share wealth, opportunities, and responsibilities between the rich and the poor—for a world where the chasm between rich and poor grows wider will be

Over the next year NATIONAL GEOGRAPHIC will present a four-part series on global challenges. "War on Disease" begins on page 4. Look for stories on food safety and modification in May.

Long concerned with human rights issues, former U.S. President Carter meets African dancers in 1989.



ELI REED, MAGNUM PHOTOS


neither stable nor secure. So far we have not made enough of a commitment to this goal. Nearly a billion people are illiterate. More than half the world's people have little or no health care and less than two dollars a day for food, clothing, and shelter. Some 1.3 billion live on less than *one* dollar a day. At the same time, the average household income of an American family is more than \$55,000 a year, with much of the industrialized world enjoying the same, and in some cases an even higher, standard of material blessings.

The best measurement of a nation's wealth is its gross national product (GNP)—the total output of goods and services. The nations of the European Union have set a public goal of sharing four-tenths of one percent of their GNP with the developing world. But the United States and most other rich nations fall far short of this goal. Our contribution must increase greatly if we are to face future challenges to humanity with any real hope of success.

A partial answer to the problem lies in a growing number of private efforts, some quite small. For instance, during the past 20 years the Carter Center has focused more than half its effort and resources on health care in Africa and Latin America. Experts have helped us identify some of the diseases we can hope to eradicate. One is caused by a parasite called

guinea worm. When our guinea worm program started, more than 3.5 million people had this painful, debilitating disease, mostly in remote parts of Africa where only contaminated water is available to drink. We have now reduced this number by 98 percent. Only 70,000 people remain affected—almost all of them in the war zone of southern Sudan—and we are working hard to address their plight. In our fight against river blindness, another tropical disease, we have traveled to villages to treat more than seven million people each year—none of whom now will face possible blindness from the bite of a little black fly.

The success of these efforts reaffirms my faith that this is a time not for despair but for a global commitment to make the most of our scientific knowledge to address the problems of our age. Over the next year NATIONAL GEOGRAPHIC will highlight challenges for humanity in the 21st century: the global fight to control disease, to make our food safe and our water clean, to live together fruitfully in megacities. The problems may seem insurmountable, but they are not. We have the tools; we have brilliant, dedicated people to find answers. All we need is a sense of sharing and the will to change. The will can grow from understanding. Once we understand, we can care, and once we care, we can change. □



Medics train for  
casualty situations  
at the U.S. Army  
Medical Research  
Institute in Fort  
Detrick, Maryland.  
Their work will  
kill the world's most feared  
microbes, including  
anthrax and Ebola.



CHALLENGES FOR HUMANITY

# War on Disease

Just a few years ago medicine seemed to be winning the fight against disease. But now old adversaries are coming back and new infections are emerging, exposing us all to serious, sometimes unexpected, threats.

By Rick Weiss

Photographs by Karen Kasmauski



## Global Connections

An international border is no barrier to disease. As people move back and forth between the Mexican city of Mexicali, at right, and the U.S. town of Calexico, at left, to look for work, visit relatives, or do business, disease-producing microorganisms can easily hitch a ride. Migrants





from Mexico, who may never have **seen** a doctor in their lives, can import diseases that have been almost eradicated in the U.S. Likewise, travelers to Mexico can carry diseases to remote areas that have never before experienced them. The result is the same: a public health problem.



## Head Start

Nutrition makes a big difference to tiny patients at a research hospital in Dhaka, Bangladesh. Admitted with diarrhea, all weighed 50 percent below the norm for their age. Two recent arrivals are still scrawny, but the baby on the right is ready to go home after three weeks of eating



locally available, calorie-rich foods. Without such intervention many severely malnourished children succumb to disease. With half its babies born underweight, Bangladesh—like many struggling nations—has begun to educate women about nutrition.

## We concluded that microbes were no competition for

**I**T WAS HOT. Swamps stretched before him in every direction. And there were mosquitoes. Lots of mosquitoes. Those were the things Steven Wiersma noticed first as he stepped out of his car last summer in rural Sirmans, Florida. Everything was typical Florida—except for the one thing that Wiersma, the state's chief epidemiologist, had come to investigate.

The guts of those swarming mosquitoes, Wiersma had recently learned, were filled with a virus from a far-off land—a virus that had never inhabited the Western Hemisphere until 1999 but which had taken an instant liking to it. That virus—named for its homeland, the West Nile district of Uganda—had found the United States to be a bountiful place. Plenty of birds to live and breed in. And plenty of mosquitoes to spread the virus from bird to bird—or as was beginning to happen with somewhat alarming regularity, from birds to people.

People like 73-year-old Seymore Carruthers of Sirmans, who lay in a coma with encephalitis in a Tallahassee hospital that week because

he'd been bitten by one of those infected mosquitoes. It was just about the farthest south in the continental U.S. the virus had ventured since arriving in New York State two years earlier. And it was ominous evidence that the bug was settling into the nation's Sunbelt, home to so many mosquitoes and to so many of the nation's elderly—least capable of fighting off infection by the virus.

Looking around the neighborhood, Wiersma could easily see how Carruthers had been felled. Mosquitoes breed in stagnant water, and there was plenty of it around—a direct result of more people and more of their trappings. In addition to the area's natural swamps there were tarpaulins draped over farm and construction equipment, puckered with little pockets of rainwater. Birdbaths. Abandoned buckets in yards. Every stray puddle teemed with millions of mosquito larvae. "Where these people live, mosquito bites are part of daily life," Wiersma says. "It hasn't always mattered so much. But it's mattering more and more."

The recent and wholly unanticipated eruption of West Nile fever in the United States has



# our big human brains. We were wrong.

## ANIMAL VECTORS

Data from a deer mouse, trapped temporarily, will help scientists in New Mexico understand a hantavirus. Viral particles excreted by infected mice can cause respiratory failure if breathed in by humans.

In the summer of 2000, New York City used chickens to determine the arrival of the West Nile virus. Antibodies in blood drawn weekly (below left) indicated that an infected mosquito had bitten a bird.



been a sobering experience for public health officials, who estimate the virus has already infected tens of thousands of Americans, sickening more than 2,000 and killing about a dozen. Far more sobering, however, is that West Nile pales in comparison with the many more ferocious infectious diseases—including those delivered intentionally by terrorists—emerging and reemerging around the globe.

Ebola is one familiar example, though that virus, it turns out, is too deadly for its own good; it kills its human victims so fast it has little opportunity to transfer from person to person and so is unlikely ever to grow into a full-fledged pandemic. But other ailments—some famous, some obscure—pose increasingly serious hazards. The mosquito-borne viruses that cause fatal dengue hemorrhagic fever and its sister disease, yellow fever—both supposedly vanquished by the 1940s—are again resident through much of South and Central America, and dengue has recently made inroads into the Caribbean and the southern United States. And with more people on the planet providing more places for mosquitoes to breed, the stage is set for a public health disaster of hemispheric proportions.

Tuberculosis has grown coldly resistant to the effects of modern antibiotics in the former Soviet Union and other regions of the world. With its ease of transmission by invisible

respiratory droplets and its close association with HIV, TB is in an excellent position to wreak global havoc in the new millennium. And malaria, which already kills an estimated 1.2 million people annually—more than half of them children—has grown similarly resistant to standard medicines.

The list goes on: Rift Valley fever, hantavirus, cholera. At least 20 major maladies have reemerged in novel, more deadly, or drug-resistant forms in the past 25 years. Worldwide, scientists have discovered at least 30 previously unknown human diseases for which no cure exists, such as Marburg disease and AIDS.

That's a humbling reality given that just a couple of decades ago experts declared that many infectious diseases were on the brink of extinction. Improved sanitation, mosquito control, global vaccination, and modern antibiotics appeared to have won the war, and self-assuredness spawned complacency. Flush with our early successes against them, we concluded that microbes were no competition for our big human brains. We were wrong.

Largely unnoticed the world was changing. In developing nations, people were hacking their way into previously inaccessible areas, where a menacing menagerie of bacteria and viruses skulked about, hungry for new warm-blooded hosts. Third World metropolises grew increasingly crowded, overwhelming sewage

# Global Enemies

Six maladies alone account for 90 percent of the deaths from infectious diseases worldwide. Spread in different ways and influenced by different factors, they continue to resist control. Aggravating social, economic, and political

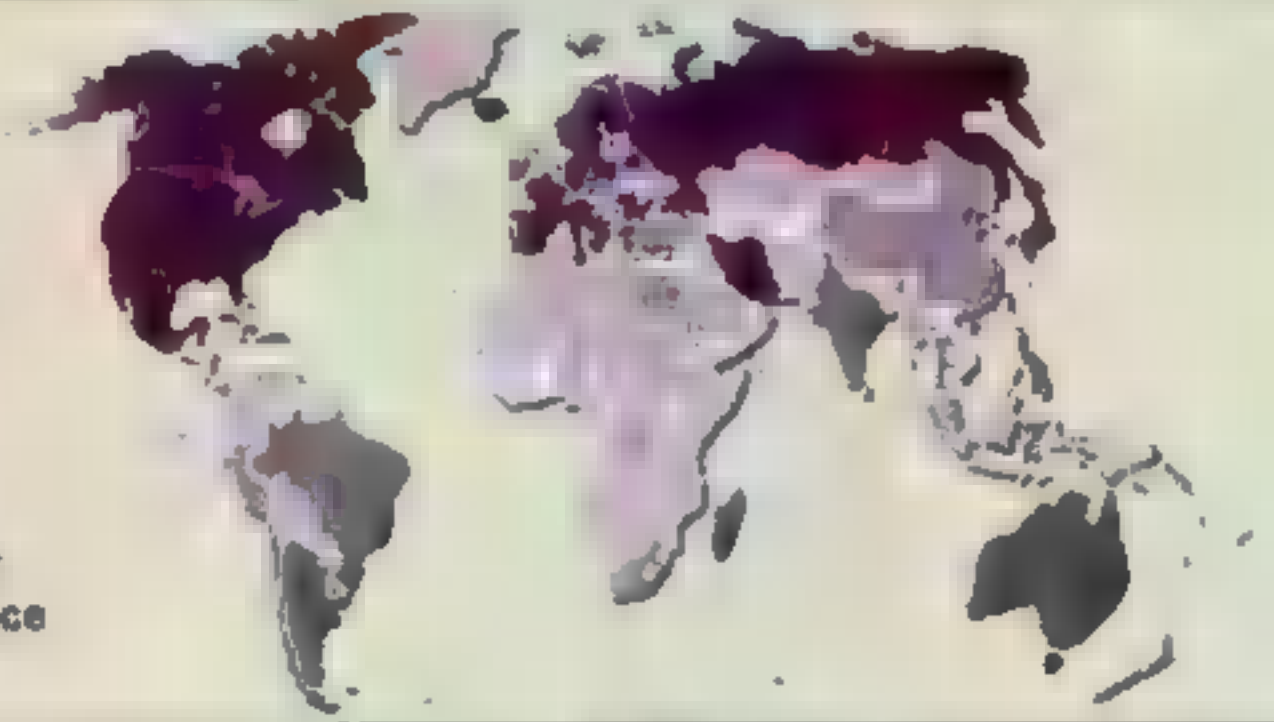
instability, these diseases have increasingly become global security threats. Large, densely populated cities in developing countries, where most of the world's people now live, are especially vulnerable.

## Influenza

Prone to mutate, influenza viruses continually appear in different forms, requiring the production of a new vaccine each flu season. In some years the symptoms are mild; in others they can be lethal. Three episodes were especially virulent: the influenza pandemic in 1918-19, the Asian flu in 1957-58, and the Hong Kong flu in 1968-69.

### Outbreaks

- Widespread
- Regional
- Local
- Sporadic
- Negligible or no surveillance
- NG

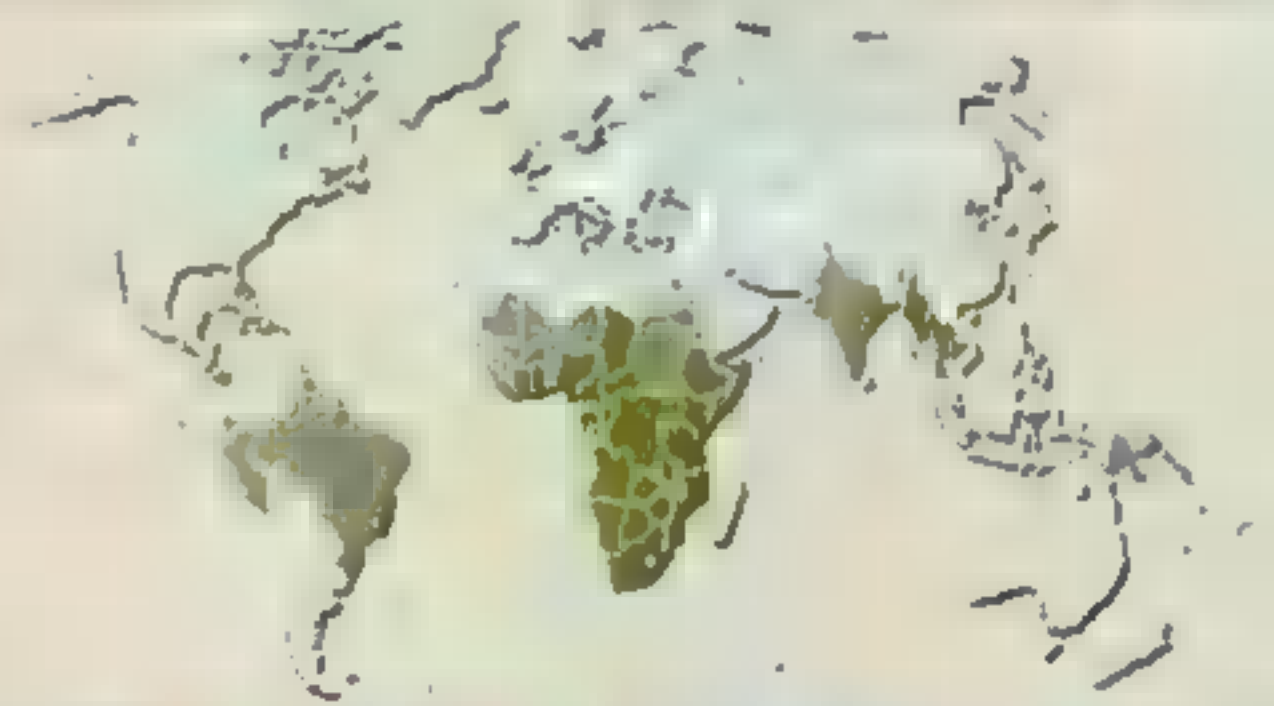


## HIV/AIDS

Passed on through bodily fluids, human immunodeficiency virus, or HIV, almost invariably leaves the body defenseless against the infections that define full-blown acquired immunodeficiency syndrome, or AIDS. Sub-Saharan Africa, with one-tenth of the world's population, has more than 70 percent of all HIV cases.

### Mortality

- High
- Moderate
- None or low

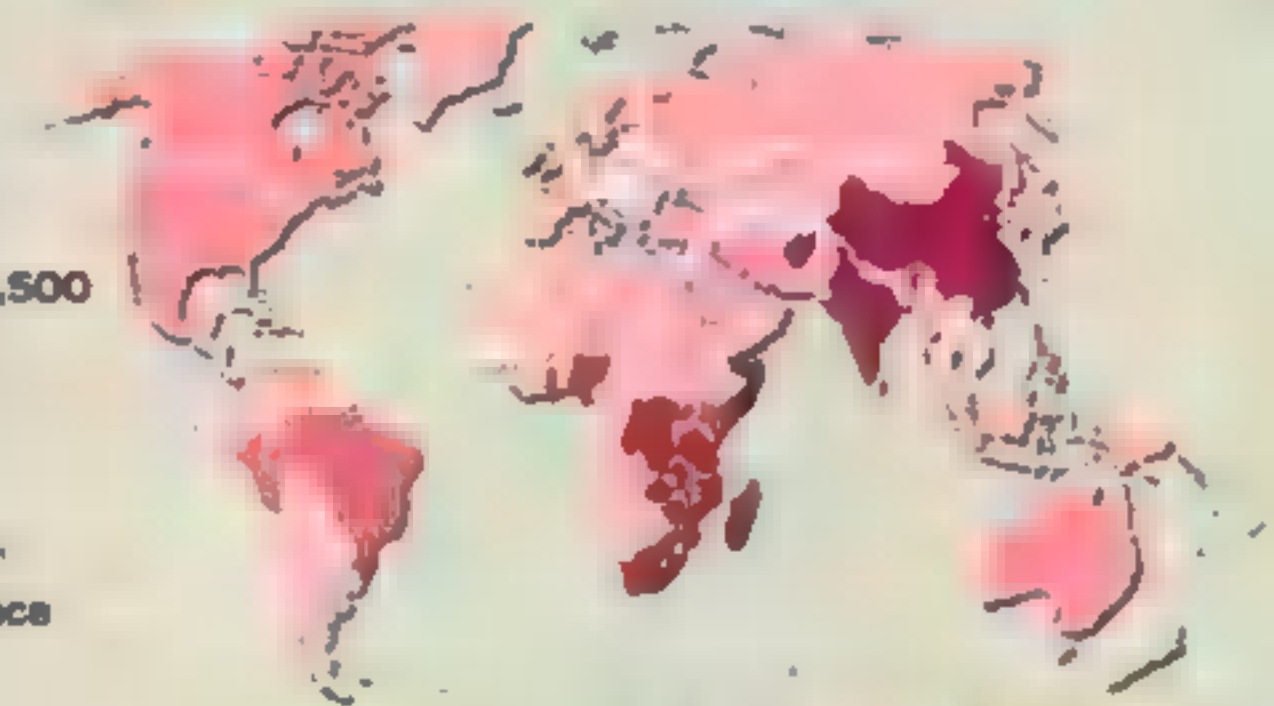


## Diarrheal Diseases

Waterborne bacteria, viruses, and parasites produce about four billion cases of diarrhea a year. Those at highest risk include the 1.1 billion people lacking access to safe drinking water and the 2.4 billion without adequate sanitation facilities. Cholera, an acute diarrheal disease, claims more than 5,000 lives a year.

### Cholera Cases

- More than 1,500
- 1,001-1,500
- 501-1,000
- 1-500
- Negligible or no surveillance

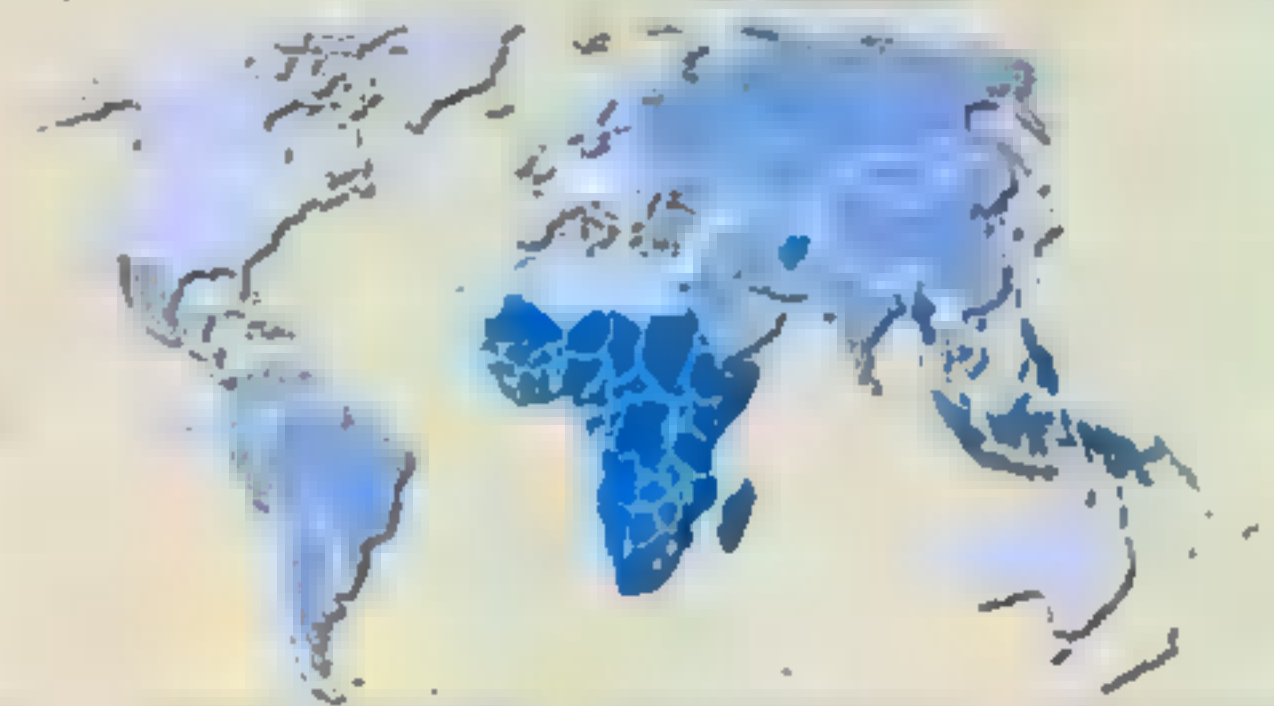


## Tuberculosis

Propelled by a cough or sneeze from an infected person, tuberculosis bacteria can begin to grow in the lungs and throat of anyone who breathes them in. Drugs discovered in the 1940s beat back the disease, but the bacteria have recently begun to develop resistance, and tuberculosis has reappeared with a vengeance.

### Mortality

- High
- Moderate
- None or low

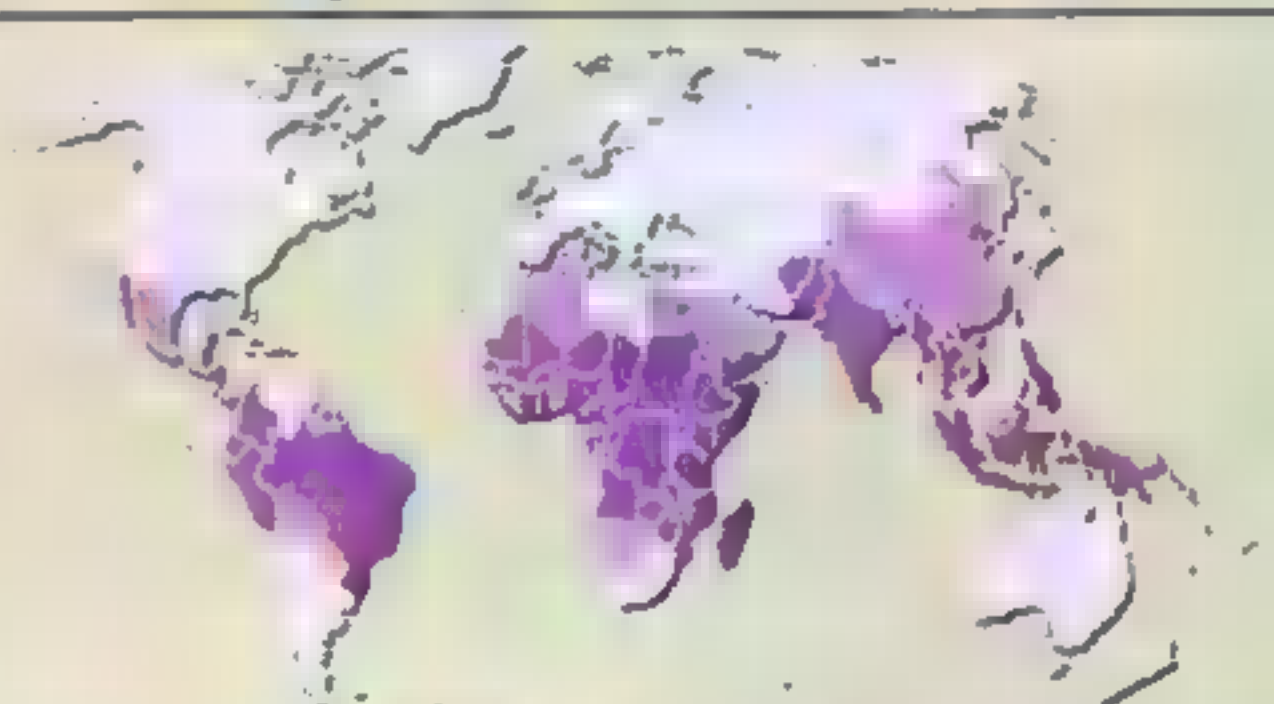


## Malaria

Caused by microscopic parasites transmitted by the bites of infected mosquitoes, malaria attacks red blood cells. Global warming has expanded the range of malaria-carrying mosquitoes, putting more than 40 percent of the world's population at risk. In addition, warmer weather makes mosquitoes breed faster and bite more often.

### Risk

- Significant
- Low
- None

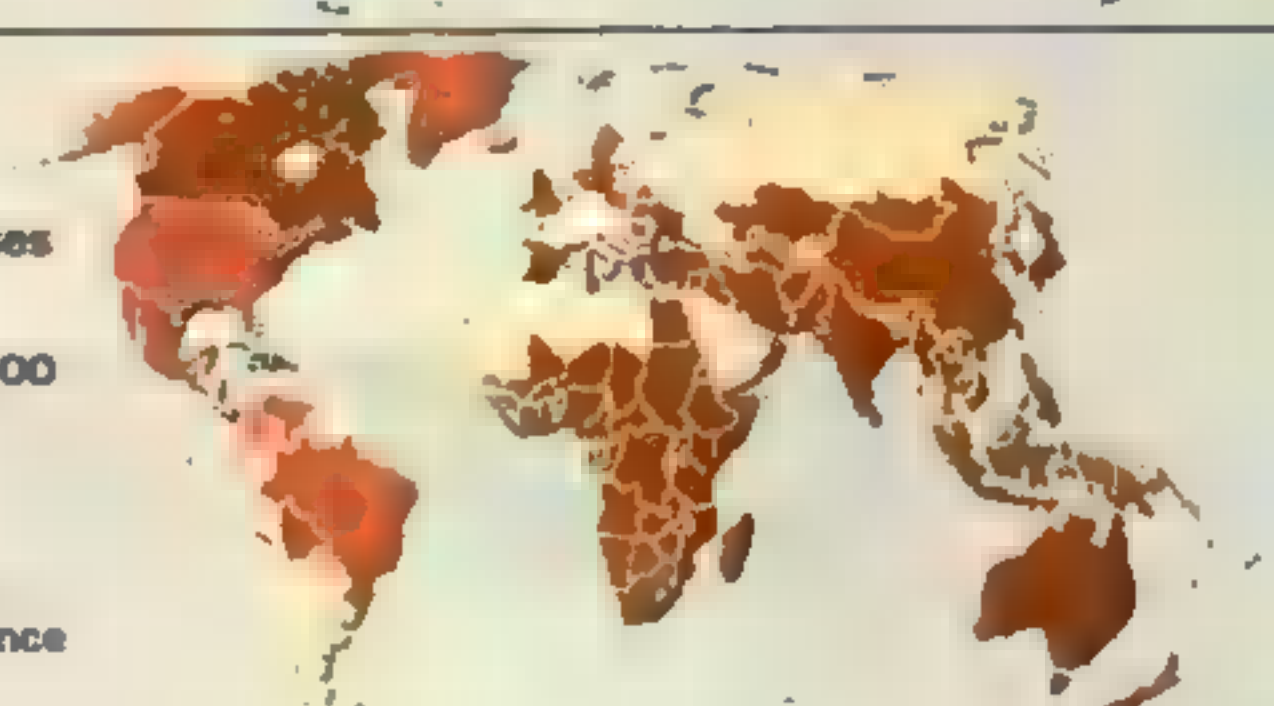


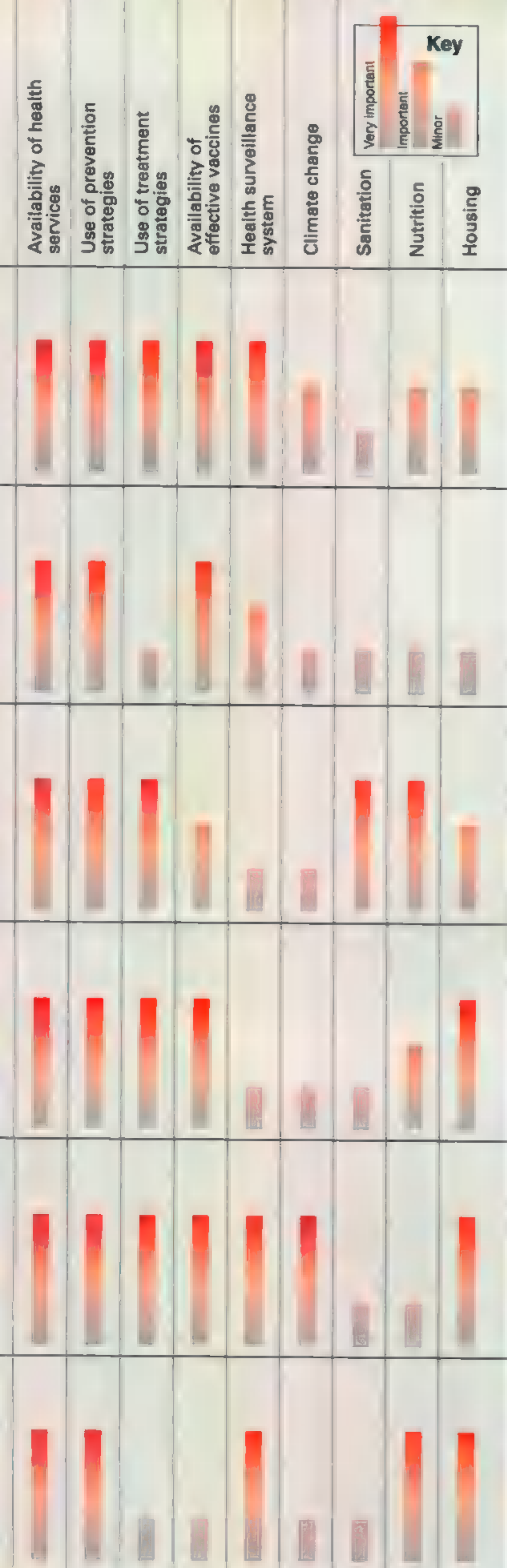
## Measles

A highly contagious viral disease that can lead to pneumonia or encephalitis, measles was an inevitable rite of childhood until an effective vaccine became available in 1963. Still striking more than 30 million a year and killing some 900,000, it is the world's leading cause of vaccine-preventable death in children.

### Number of cases per 100,000

- More than 100
- 11-100
- 1-10
- 0
- No surveillance





and water systems and providing a microbial mixing bowl for the creation of new diseases. Wars in nations least able to afford them spawned immense human migrations and refugee settlements with little or no sanitation or medical care. And changing patterns of temperature and rainfall allowed disease-carrying insects to extend their range.

“The world definitely favors the bugs; microbes have the advantage,” says Jim Hughes, Director of the National Center for Infectious Diseases at the Centers for Disease Control and Prevention (CDC) in Atlanta. “There are a lot more of them than us. Their generation time is minutes instead of years. They evolve rapidly. And, of course, we aid and abet them in many ways—by travel, commerce in foodstuffs, transportation of animals, and our abuse and overuse of antibiotics. We’re playing right into their hands.”

**P**LAGUES ARE NOT NEW to humanity, of course. Smallpox thrived long before the Egyptian pharaohs, and it continued to kill one-third of those it struck until, after a heroic international vaccination effort, the last human was afflicted in 1978 and the disease officially eradicated in 1980. In its final century on Earth, smallpox killed more than half a billion people.

The plague of the 14th century, known as the Black Death, wiped out about a fourth of Europe’s population in just four years—a tidal wave of death almost unimaginable today. Ignorant of its cause and paranoid of the air itself, medieval society quickly descended into panic and mayhem.

Then came the discovery of the New World, offering microbes a new and deadly windfall. After Columbus first dropped anchor in the West Indies, the native population of the Americas declined drastically, largely from diseases that arrived on European vessels, many of them carrying African slaves.

And as recently as 1918-19 the great global influenza pandemic left at least 20 million dead. By comparison, World War I, fought between 1914 and 1918, claimed 8.5 million casualties.

In many respects microbes have it even easier today. With modern technology, centralized systems of food and water distribution in developed nations tend to amplify the impact of otherwise modest microbial blooms. When

MAPS ADAPTED FROM WORLD HEALTH ORGANIZATION DATA.  
 CHART ADAPTED FROM 1999 DATA, WHO  
 DISEASE IMAGES: CUSTOM MEDICAL STOCK PHOTO; MEASLES BY  
 CENTERS FOR DISEASE CONTROL



## Influenza: Past and Present Danger



world. To understand what made that flu so deadly and what can be done to keep similar strains from spreading now, Taubenberger's lab is trying to reconstruct the gene sequence of the virus using fragments of RNA from tissue samples (left) preserved at the institute since 1918.

New strains of influenza usually arise in countries like China (below), where the virus can move among pigs and birds kept close to their human owners. With each relocation the virus's genes can change just enough to present a health risk the following flu season.

Army recruits stricken with influenza during the great pandemic of 1918-19 fill a gymnasium at Iowa State University (top). "The U.S. lost about 100,000 soldiers in World War I. Of those, 43,000 died of the flu," says Jeffery Taubenberger, a division chief at the Armed Forces Institute of Pathology in Rockville, Maryland. "You'd have to go back to the Black Death to reach that level of mortality in a single outbreak."

The pandemic killed at least 20 million people around the



UNIVERSITY OF MICHIGAN LIBRARY; IOWA STATE UNIVERSITY LIBRARY AMLS (TOP)



Lake Michigan became contaminated with the intestinal bug *Cryptosporidium* in 1993, hundreds of thousands of residents in Milwaukee were infected. When one U.S. fast-food chain sold undercooked hamburgers tainted with a virulent strain of *E. coli* bacteria in the same year, hundreds of children fell ill, and several died. And far-flung outbreaks of severe diarrheal disease have been traced to apparently healthful seed sprouts that were grown from contaminated seeds and then widely distributed from a single source. In the worst case, white radish was implicated in a Japanese *E. coli* outbreak that sickened about 10,000 and killed 11 in the summer of 1996.

**I**T'S BAD ENOUGH that in today's crowded and interconnected world small outbreaks can blossom inadvertently into huge epidemics. Equally worrisome, however, is the fact that terrorists can take advantage of that modern vulnerability and intentionally sow the seeds of a devastating disease.

A bioterrorism attack, as difficult to counter as almost any act of war, combines the best of microbial lethality and human ingenuity. Billions of infectious particles can be stored in a small vial, much easier to smuggle into a country than a nuclear device. Computer models have shown that an intentional outbreak of smallpox (public health officials report that some samples of the smallpox virus, stored for research after the disease was eradicated, are now unaccounted for) could spread uncontrollably almost before officials could take action to contain it. And as the U.S. learned firsthand in October, even a noncontagious disease like anthrax can wreak enormous havoc if it finds its way into the nation's mail system.

To a terrorist perhaps the most attractive feature of a plague is its fantastic capacity to create social unrest and political instability. "Infectious agents have the potential to trigger panic and fear like no other weapon," says Michael Osterholm, director of the Center of Infectious Disease Research and Policy at the University of Minnesota—and an epidemiologist with a worldwide reputation for his disease-sleuthing skills. "It's horrible to be eaten from without by a lion or something, but it's equally horrible to be eaten from the inside out by some terrible bug and to see that going on all around you. It's a very primal fear."

Bioterrorism was already a matter of heightened concern when planes crashed into the World Trade Center and the Pentagon on September 11. The CDC immediately warned U.S. public health agencies to be on the lookout for "unusual disease patterns associated with the events of September 11," a chilling hint of fear that the country might be under biological attack. A biowarfare unit from the CDC and a military team specially trained in disease detection were rushed to New York. As part of the security crackdown that followed the hijackings, federal officials temporarily grounded the nation's fleet of 3,500 crop duster airplanes, which they feared might be used to release a cloud of deadly microbes. When anthrax attacks did materialize a few weeks later, billions of dollars in resources were quickly redirected to bioterror defense.

And yet the recent emphasis on bioterrorism obscures a more pedestrian but equally important truth about infectious diseases: Even without the element of intentional terror, diseases are a huge source of human suffering—and a tremendously destabilizing force. Nearly half of the world's premature deaths (defined as deaths under the age of 45) are caused by infectious diseases. Some 30 million infants in developing countries remain unprotected by the lifesaving childhood vaccines that in the rest of the world are administered routinely; a million die each year from measles alone. It may not be obvious in the healthier nations, but from a microbe's point of view the world today—even with modern antibiotics and fancy vaccines—remains a virtual smorgasbord. With the recent reemergence of some of these diseases in richer nations, there is a growing recognition that no nation is an island.

"The lesson of West Nile is that any country is vulnerable," says David Heymann, executive director of communicable diseases at the World Health Organization in Geneva. "Countries have to realize that infectious diseases, regardless of their origins, can travel widely and affect anyone." No nation, no matter how rich or seemingly protected, can be assured of a healthy and peaceful future as long as any nation is still an active breeding ground for the world's many and varied scourges.

Encouragingly, that reality is sinking in. A 1999 CIA report, an (Continued on page 26)

## TB: The Growing Epidemic



Sick with tuberculosis, inmates at a Siberian prison wash down their medicine with milk (below). Because incomplete or interrupted treatment can allow the TB bacteria to strengthen their defenses against first-line drugs, masked health care workers watch to make sure every tablet is taken. Multi-drug-resistant tuberculosis, MDR-TB, is more difficult and



costly to cure and kills many who have no access to modern medical facilities.

Until their treatment takes hold, TB patients have little contact with healthy prisoners like Grigory Morozov, saying good-bye to his wife, Olga (right), after a conjugal visit. "Of course I'm worried about getting TB and passing it on to my daughter," says Olga. "I get tested every



**"TB can become drug-resistant in prisons, when inmates fail to take all their medicine or when they're released before completing treatment."**

—PHOTOGRAPHER  
KAREN KASMAUSKI

three months, and so far I'm fine."

Tuberculosis is more likely to be spread by the prisoners themselves if they are released while still contagious. No longer quarantined or compelled to take their medicine, they are likely to infect an average of ten to fifteen new victims a year.

With one-third of humanity now carriers of tuberculosis, the disease has become everyone's problem. Each year the U.S. Public Health Service screens the estimated 200,000 people caught trying to enter the country illegally, including a man being x-rayed in El Centro, California (above left). Some two million more cross the border undetected—and untested.





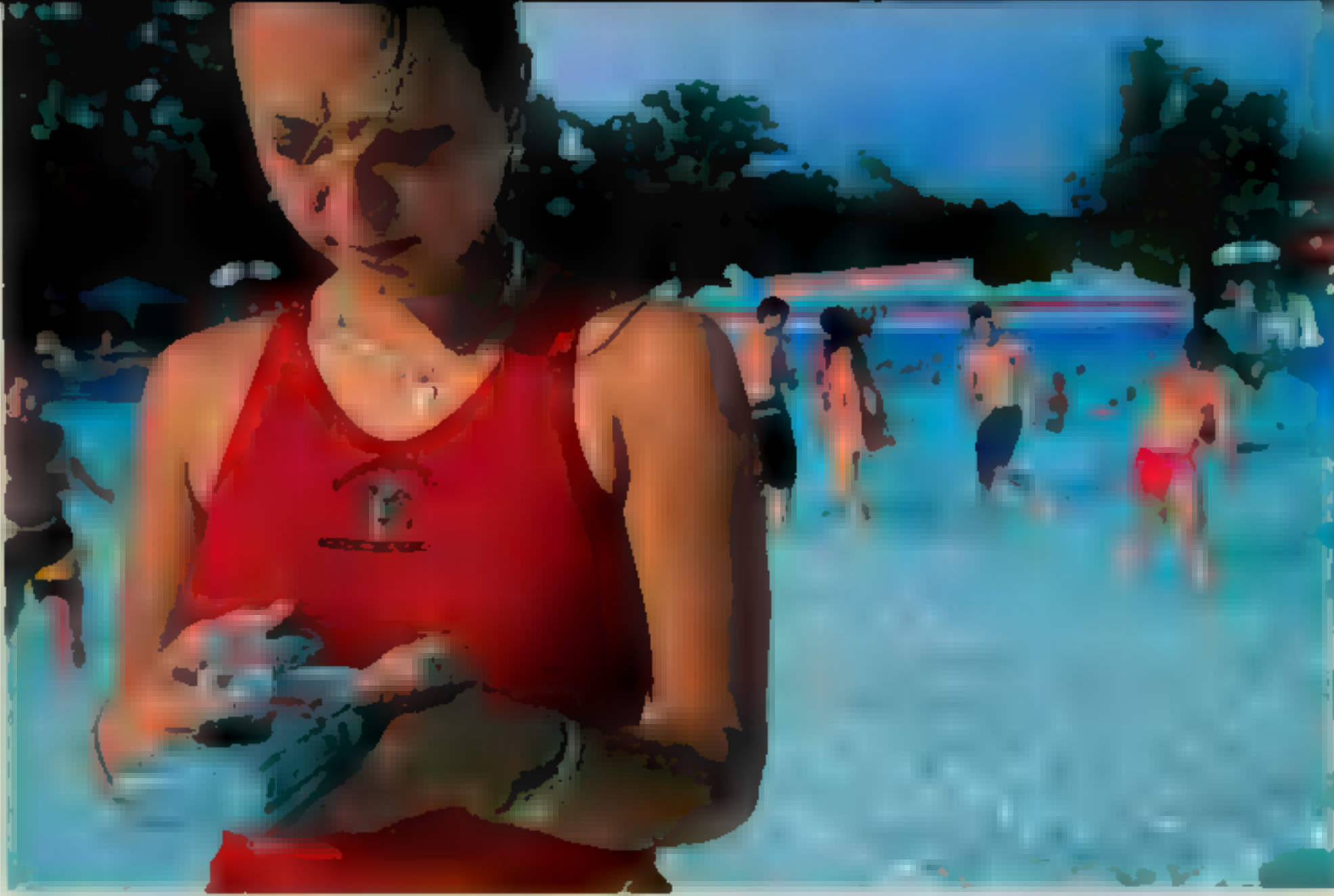
## Basic Sanitation

Nature provides the only plumbing for a pondside outhouse in Dhaka, Bangladesh. Crowded with people who have moved from the countryside, such urban neighborhoods have public faucets that deliver drinking water, but residents often bathe, wash clothes, and swim in the



witches' brews of contagion that swirl around their homes. With the global consumption of fresh water doubling every 20 years, many other countries will surely join Bangladesh in struggling to supply even the minimum amount needed to keep their citizens healthy.

## Simple Solutions

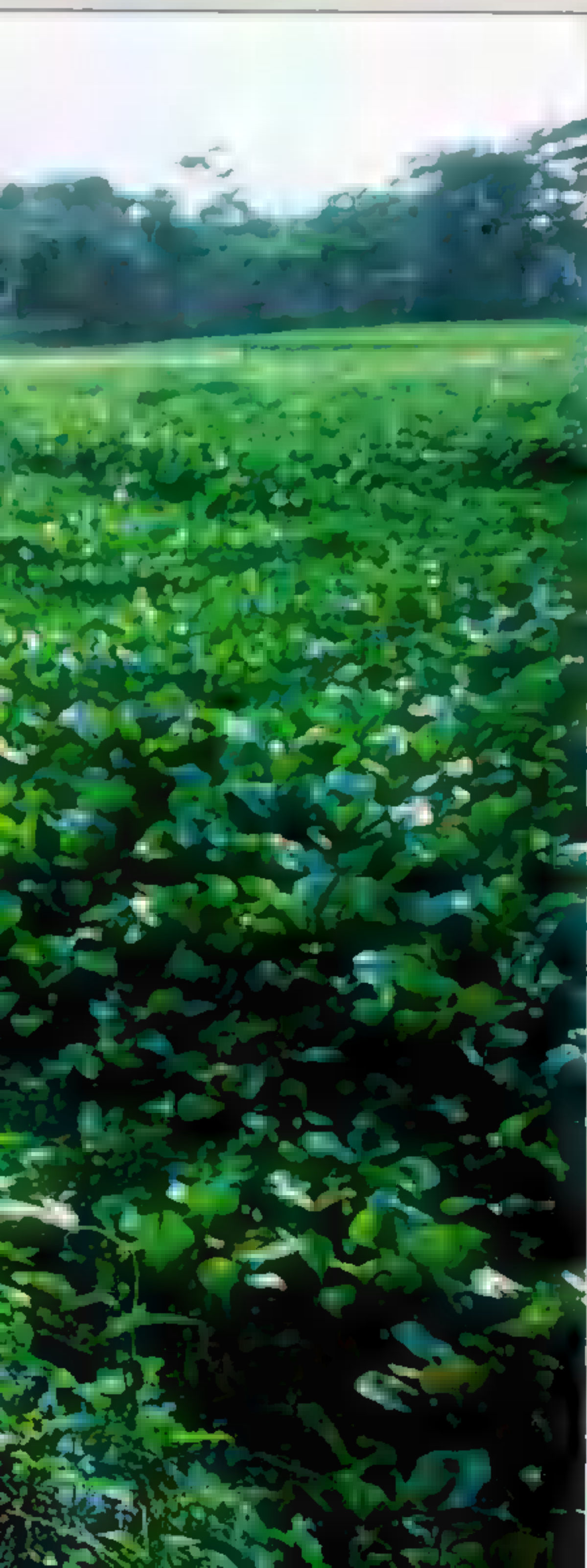


On the alert at Water Country USA in Williamsburg, Virginia, Brooke Abbitt tests the amount of chlorine in a water sample from the wave pool (left). Chlorine at the proper level disinfects the pool after fecal accidents.

Cholera plagues Bangladesh, especially around the spring and summer monsoons, which flood much of the country. People who still



get their drinking water from the lakes and ponds in rural areas are the most susceptible, but they are now beginning to practice a recently devised method of protection. Folding clean, dry sari material several times (below) and placing it over the mouth of a jug before collecting water creates a barrier against plankton to which the cholera bacteria are attached.



**“Many infectious diseases have a water connection, but often there’s an easy solution that will stop people from getting sick.”**

—KAREN KASMAUSKI

Improved agricultural hygiene can help stop the transmission of intestinal bugs internationally. When more than 2,000 people in the U.S. and Canada fell ill from the cyclospora parasite carried by Guatemalan raspberries in the late 1990s, suppliers cleaned up their operations. New wells now deliver clean water to the fields, and pickers begin work (above) only after washing their hands. “Farms are carefully reviewed by inspectors on a regular basis,” says Robert Klein, a research director from the U.S. Centers for Disease Control and Prevention who helped implement safety measures. “It all seems to be working. There haven’t been any subsequent outbreaks.”



Timothy J. McCarthy

Day's first light in Niger finds a family of cattle herders still asleep under a net meant to keep away the mosquitoes whose bites transmit malaria. These people have few possessions, yet they recognize the importance of owning such simple, effective protection. Of the four species





of malaria parasites that infect humans, the commonest in Africa is the most deadly. In addition, malaria has become increasingly resistant to chloroquine, the drug used for decades to treat it. The disease kills more than a million people a year worldwide, mostly children.

## Case Implications

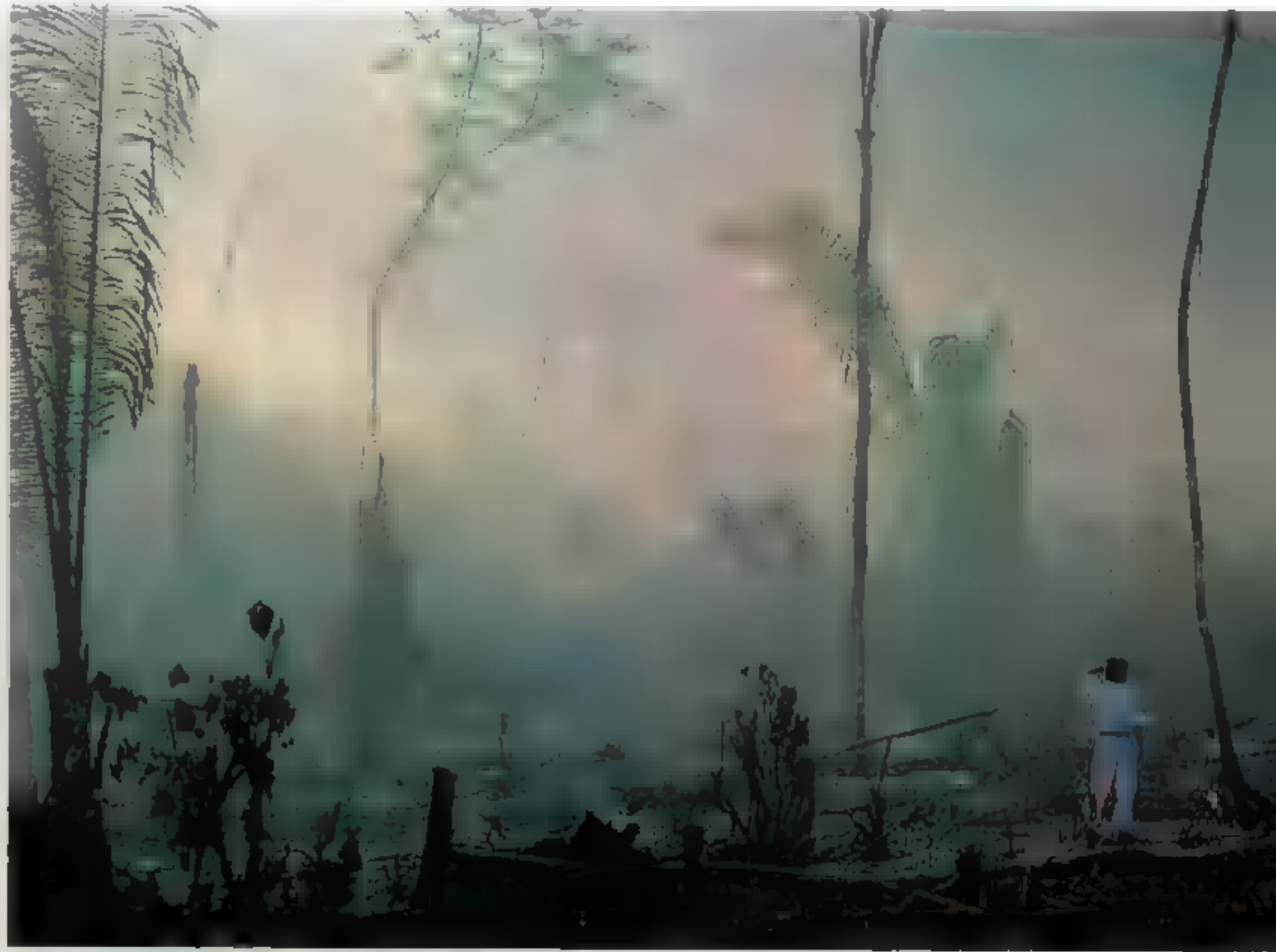


The incidence of Lyme disease, transmitted by the bite of the blacklegged tick, has risen significantly in the wooded suburbs of the northeastern U.S. in the past few decades. Monitoring the tick population for the state of Connecticut, entomologist Kirby Stafford counts nymphs on a cloth he dragged along the shady edge of a backyard in Westport (left).



During part of the cycle that perpetuates Lyme disease, adult ticks feed on deer. More deer mean more ticks and more illness. "In 1896, it's estimated, there were 12 deer in Connecticut," says Stafford. "The latest figure is more than 76,000."

Bitten by a sand fly carrying the leishmania parasite, a Guatemalan subsistence farmer bears lesions



**"People want forests around their houses in Connecticut, so they're building up the trees. It's deer heaven now, and there are ticks everywhere."**

—KAREN KASMAUSKI

characteristic of infection (left). If the disease is not treated, such lesions can take months or years to heal and result in permanent scarring.

Economic necessity and political pressures send more and more campesinos into sand fly territory, the untouched rain forest in the country's north. Following an age-old rhythm, farmers from the village of Tierra Blanca in the Petén have abandoned their exhausted fields and slashed-and-burned trees (above) to begin planting their crops anew. In other parts of the forest the government has resettled people displaced by the country's long civil war. Their homes, built in the shadow of the forest, put whole families in jeopardy.

## The watchword is “surveillance,” and it is the

(Continued from page 15) unclassified version of which was released in 2000, for the first time labeled global disease as a national security threat, elevating microbes to a level of political concern usually accorded nuclear warheads. Also in 2000, the United Nations Security Council convened a meeting to discuss the security threat of AIDS, the council’s first meeting devoted to a health issue.

It’s an important, even revolutionary, insight: Nations can enhance their own stability by taming diseases abroad. The catch is that public health improvements are difficult to implement in countries that are politically unstable or at war, as many of the world’s most plague-afflicted nations are today.

The tale of Bonzali Katanga offers a tragic case in point. Katanga was the sole public health officer for the town of Durba in civil-war-torn Democratic Republic of the Congo in 1998. The country’s central government was a shambles, and Katanga’s district was held by rebels. When men started dying by the dozens in the local gold mine, Katanga suspected Ebola or perhaps Marburg disease, caused by

a similarly destructive virus. For months he tried desperately to raise the alarm, sending repeated radio messages to his superiors in the provincial capital of Kisangani while doing what little he could for his hemorrhaging patients. It took more than four months for officials to respond, and by the time they got there, Katanga was dead too. They found a vial of his blood in the refrigerator, which he had left to aid their investigation. Researchers later determined that it contained the deadly Marburg virus, which he’d contracted from the miners he had cared for until his own demise.

Katanga’s death was the worst kind of proof that political instability and disease go hand in hand, an American doctor who knew him said later, shaking with anger and grief. “I consider him a casualty of war.”

Ironically, Bonzali Katanga was doing exactly what global health officials say needs to be done if emerging diseases are to be controlled. He was on the ground, keeping his eyes open, and alerting authorities to anything that appeared to be infectiously amiss.

The watchword is “surveillance,” and it is



## linchpin in the battle against emerging diseases.

### ERADICATION EFFORTS

Blinded by smallpox half a lifetime ago, a man in Niger is checked for trachoma (right). A global vaccination campaign against smallpox, launched in 1967, eliminated the disease by 1980.

Spread by water, the disease caused by guinea worms will likely disappear soon, after a decade-long drive encouraging the use of water filters in endemic areas. A farmer getting treatment in Niger may be among the last cases.



the linchpin in the battle against emerging diseases. It need not be complicated or high-tech. When the cryptosporidiosis outbreak hit Milwaukee in 1993, it took officials many days to recognize they had a problem on their hands. The causative organism was not one they tested for routinely. And the foremost symptom of infection—severe diarrhea—was not the kind of thing people typically called their doctors about, at least not at first.

After the epidemic was brought under control, health officials conducted a retrospective study to see how they might have picked up on it sooner. The very best and earliest indication of trouble, they found, had been a vast increase in sales of over-the-counter antidiarrheal medicines—a simple sales spike that went unnoticed because no one was looking for it.

Milwaukee and other cities caught on. Now, for example, the New York City department of health has an arrangement with the Rite-Aid drugstore chain to receive weekly antidiarrheal sales data. In New Mexico, public health officials are starting to tally symptoms of people in emergency rooms and are using computers to look for groups of symptoms that might indicate the spread of a disease through the community several days before microbial culture results begin to yield clues.

But there's a place for high-tech surveillance as well. In perhaps the best example, scientists

at 110 centers around the world collect samples of the influenza virus from patients each winter and conduct sophisticated genetic tests on those viruses, which mutate continually from year to year. The scientists pool this information to predict which strain will dominate in the upcoming year, and vaccine companies rush to make new batches of exactly the right vaccine just in time for the next flu season.

"It's an amazing and heroic effort that enables the pharmaceutical companies to make very effective vaccines," says Barry Bloom, dean of the Harvard School of Public Health. "Our best protection is to know what's coming. With flu we're doing an astonishingly good job."

While vaccines are by far the most effective and cost-efficient weapons in the war against infectious diseases, precious little money is being spent on the development of new ones today, and vaccines for HIV, TB, and malaria remain elusive. Again, cooperation is required. For inspiration one need look no further than the current campaign against polio.

Thanks to an enormous international effort, polio may be eradicated as early as 2005. To accomplish that goal, countless dedicated health workers have been trekking into every village in the developing world and squeezing lifesaving drops of vaccine into the mouth of every child they can find.

The scale of the effort is almost beyond



## Line of Defense

Safely suited up, an airborne evacuation team from the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) practices a rescue in Martinsburg, West Virginia. USAMRIID researchers devise protective strategies for both U.S. military personnel and civilians, and they



can protect medical researchers in the field who might come in contact with any of the world's worst infectious agents—whether occurring naturally or spread intentionally. In a real emergency the team would place a patient in a self-contained litter for transport.

## Thanks to an enormous international effort,

comprehension. During a series of National Immunization Days over the past several years, almost two billion children have been inoculated worldwide. Just in 2000, 550 million children—one-tenth of the world's population and almost 85 percent of its youth—received vaccinations, and in January 2001 India inoculated 152 million children in a single week.

The campaign has brought out the best in humanity, with entire wars suspended at times to allow health workers safe passage. In July 2001 the United Nations asked all warring parties in the Democratic Republic of the Congo to observe a cease-fire as part of the vaccination effort. Despite sporadic fighting and power outages, 11 million children were inoculated. And in a striking display of antimicrobial solidarity, Sierra Leone's president and his chief rebel rival posed for photographs together several years ago in the heat of that country's bloody civil war. They were mortal enemies, but they had a common cause that day, emblazoned on the T-shirts they both wore. "Kick Polio Out of Africa," the shirts declared.

**T**HERE IS NO VACCINE against West Nile virus, and none was under development while the disease was still ensconced in Africa. But now that it is racing through the United States, the U.S. government has started financing such an effort. And curiously, if it works, Americans will owe their thanks to a poor villager from Africa.

His name was Asibi. He lived in Ghana and came down with yellow fever in 1927. Scientists there who were studying yellow fever—a close viral relative of West Nile—isolated some of the yellow fever virus from Asibi's blood and cultivated it in laboratory dishes for years, first on a diet of mouse embryo cells and later on chicken embryo cells and eggs. The virus that survived this intensive dietary regimen became too weakened to cause disease, but when injected as a vaccine into healthy people, the virus stimulated the human immune system enough to protect the recipients of the vaccine against future yellow fever infections.

That so-called 17D strain of yellow fever virus has since been injected into the arms of 300 million people, shielding them from the





# polio may be eradicated as early as 2005.

## NEARING VICTORY

Two drops deliver a dose of oral polio vaccine to a child at a Dhaka clinic during one of Bangladesh's periodic National Immunization Days. A porter takes coolers of the vaccine to a village (below left) during a subsequent door-to-door search for children still needing protection from this crippling, sometimes fatal, disease. Such diligence should soon eradicate its last vestiges, saving future generations from untold misery.



mosquito-borne killer. Now scientists at a biotechnology firm in Massachusetts are using genetic engineering techniques to redecorate the 17D virus with a new molecular coating—one that will prime the immune system not against yellow fever but against West Nile.

The approach could be a metaphor for what it will take for humankind to stay ahead of its infectious foes. Just as microbes keep rearranging their old genomes to come up with new ways to overcome our defenses, we humans will have to draw upon everything we've ever inherited or learned—from precolonial jungle medicine to genetic engineering—if we are to stay ahead in the evolutionary arms race.

In some cases it will require incredibly sophisticated medicines, like some of those now in use to lessen the symptoms of HIV/AIDS. But more often than we once thought, simple solutions will work best. About 25 percent of childhood malaria deaths could be prevented tomorrow if children in affected areas simply slept under mosquito nets treated with insecticide. Cost: about five dollars a year per child.

Indeed, says Paul Ewald, a professor of biology at Amherst College, we can learn something about the power of simplicity from the microbes behind today's emerging diseases; microbes discovered long ago that evolution favors economy. It may be, for example, that some drugs and vaccines should be more

nuanced than today's, taking aim at only the most virulent strains of each bug. Some culprits are bound to survive anyway, the thinking goes, and they might as well be ones we can get along with. Then the few deadly individuals that do remain—by becoming resistant to drugs or by hiding—will have to compete with the much bigger population of their less virulent peers.

"To be honest and realistic, we're going to have most of these organisms living with us long into the future in one form or another," Ewald says. "In those cases we're going to need evolutionary interventions that tip the balance of competition toward the benign strains. We need to control evolution."

It's a radical idea, controlling evolution, but one that is helping shape a new vision of the microbial future. It's a future in which truly beatable diseases will be hit with the full force of modern medicine. And it's a future in which some drugs and vaccines may actually pull a few punches: dodge and feint as their targets do.

Perhaps most important, it's a future in which people will begin to see that with just six billion of us against so many more of them, we all have a stake in even the most distant emerging microbial coup. □

### MORE ON OUR WEBSITE

Learn how humans and microbes coexist—and how they don't—at [nationalgeographic.com/ngm/0202](http://nationalgeographic.com/ngm/0202).

AOL Keyword: NatGeoMag

# Amid the Unrelenting Spread of AIDS

# Search



Elijah E. [unclear] [unclear], a 34-year-old Ugandan, does daily chores near the graves of relatives felled by AIDS. With more than 36 million people now infected with HIV, AIDS continues to claim lives—and to elude scientists trying to stop it.

# for a Cure

By Michael Klesius NATIONAL GEOGRAPHIC WRITER

Photographs by Karen Kasmauski



**O**N A SWELTERING MORNING last February, a stray dog lay panting in the doorway of Clinic 17 of the Bangkok Vaccine Evaluation Group. Inside, the drone of an air conditioner filled an upstairs room where a handful of Thai nurses bustled around a 37-year-old heroin addict on an examination table. Injections had so scarred the veins in his arms that the nurses had turned him onto his stomach to draw blood from a vessel in the back of his knee. As the dark liquid trickled into the syringe the man smiled, baring gray teeth.

“This is going to be very beneficial for society,” he said.

Or so he hopes. His blood, drawn and tested twice a year, is contributing to the worldwide search for a possible preventive vaccine for HIV, the virus that causes the disease AIDS.

Some 2,500 injecting drug users in Thailand, like the man at Clinic 17, have enrolled in a trial of the first potential HIV vaccine to reach the third and final stage of clinical testing. By the beginning of last year the Thai participants were part of a group of almost 8,000 people in Thailand, Europe, and North America—all at high risk for HIV but all HIV-negative at the start of three-year trials—who volunteered to receive either injections of the vaccine, called AIDSVAX, or a placebo, without knowing which they would be given.

In high-risk groups a predictable percentage of participants—from 1.5 to 6 a year, depending on sexual or drug habits—would be expected to become infected with HIV over the course of a trial, even with thorough counseling in risk reduction. To determine if AIDSVAX might lower the percentage, follow-up blood testing takes place at six-month intervals. If the vaccine group shows a lower infection



rate than the placebo group, there is evidence that the vaccine is working. But we won't know for certain until the end of the year, when we have results from the first trials, begun in 1998-99, in Europe and North America.

What we do know is that more than 36 million people worldwide carry HIV, although 95 percent of them are never officially diagnosed HIV-positive. Every 24 hours 15,000 more become infected with the virus, while 8,000 others die of the resultant AIDS. And we know that AIDS victims suffer merciless deaths when their disabled immune systems allow otherwise treatable ailments to become fatal.

As I traveled from orphanages in Africa to hospices in Russia to clinics in Thailand, I saw

the tortured face of AIDS. It grimaced with the pain of fever and nausea. It gasped with fluid-filled lungs. It wore huge, open sores that emerged from deep in the throat and spread over the lips, neck, and torso. In advanced stages of the disease, the central nervous system can begin to deteriorate, leaving some victims powerless even to close their eyes and mouths. Nerve endings in the extremities go numb or tingle as if pricked by thousands of needles. AIDS robs the brain of its cognitive functions, leaving patients raving with dementia. It saps the body's protein, wasting muscles to the bone. Draped in nothing but skin, 20-year-olds look 70. Even then the release of death can lie weeks or months away.



### **RISKY BEHAVIORS FUEL AN EPIDEMIC**

**To keep her customers happy, a karaoke bar girl in Kampong Cham, Cambodia, puts up with intimate advances. Hired to sell beer, she may also later sell unprotected sex to supplement her meager salary. Such transactions have helped make the country's AIDS epidemic the worst in Southeast Asia, with about 4 percent of adults infected.**

**A heroin addict in Moscow prepares to shoot up (below); he learned to use clean needles in a Doctors Without Borders risk-reduction program. Nearly 50 percent of Russia's HIV infections occur among addicts sharing dirty needles.**



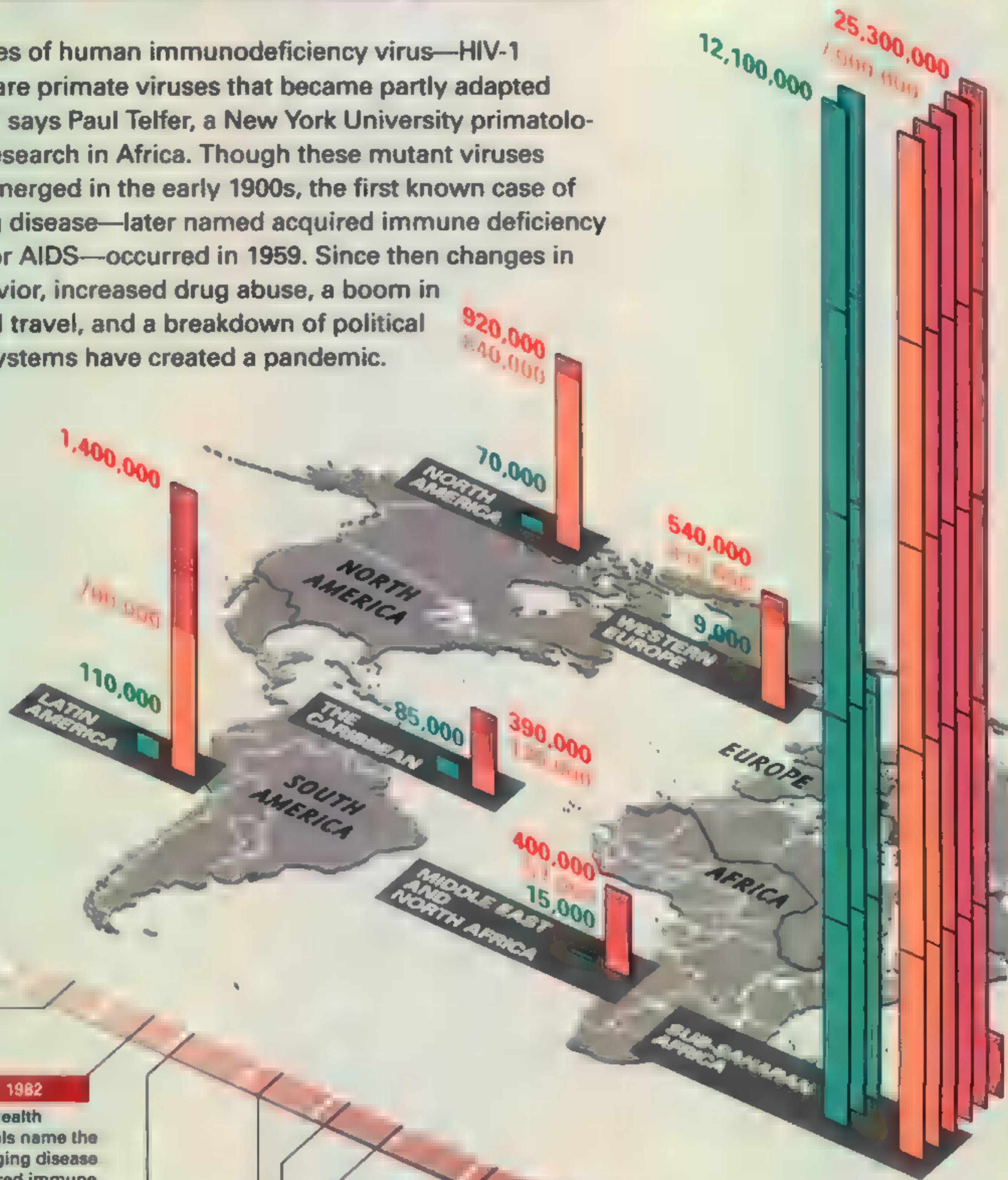
Three million people died of AIDS in 2000. As the pandemic grows, it forces the world to see what it may not want to see: That diseases arising among specific populations—prostitutes (known to HIV/AIDS specialists as “sex workers”) and their customers, drug users, and gay men—can flare into greater pandemics. That women in the developing world have little leverage to negotiate safe sex with their partners and are often abused for trying. That poverty, more than any single factor, drives the spread of AIDS by forcing young people into sex work or, as in Eastern Europe, leading them to the trap of injecting drugs. And that rich nations are often insensitive to the health problems of impoverished ones. Ninety-four out of every hundred HIV-infected people live in developing nations, where currently available drug therapies are largely unaffordable. While such medicines do not prevent infection, they do lower the level of virus in the body and may, according to some experts, thus reduce transmission rates. Many public health officials say that the drugs coupled with prevention programs in developing nations could slow the pace of the pandemic.

**D**EBATE OVER SOCIAL and economic issues surrounding AIDS lay years away when the U.S. Centers for Disease Control and Prevention (CDC) sounded the first alarm in June 1981. That month the agency issued a warning about an unusual cellular-immune dysfunction found in “five previously healthy individuals without a clinically apparent underlying immunodeficiency,” and a year later the term AIDS was coined. As the disease took on the dimensions of a plague, it swept away notions that great pandemics belong to history. It added to the understanding that an exotic family of viruses called retroviruses, more commonly seen in animals, could infect humans and cause disease. And it confirmed growing data that viruses could cause cancer in humans.

Some 20 years later “we know more about HIV than we know about any microbe ever studied,” says Robert Gallo, who headed the National Institutes of Health (NIH)

# A Scourge's Spread

"The two types of human immunodeficiency virus—HIV-1 and HIV-2—are primate viruses that became partly adapted to humans," says Paul Telfer, a New York University primatologist doing research in Africa. Though these mutant viruses may have emerged in the early 1900s, the first known case of the resulting disease—later named acquired immune deficiency syndrome, or AIDS—occurred in 1959. Since then changes in sexual behavior, increased drug abuse, a boom in international travel, and a breakdown of political and social systems have created a pandemic.



**JUNE 1981**

CDC reports an unusual immune system deficiency among gay men in the U.S.

**JULY 1982**

U.S. health officials name the emerging disease acquired immune deficiency syndrome.

**1983**

An AIDS epidemic among heterosexuals in Central Africa is recorded. A French research team reports finding a retrovirus that may cause AIDS.

**APRIL 1984**

Dr. Robert Gallo of the National Cancer Institute at NIH announces that his team of scientists has isolated HIV and developed a blood test for it.

**End of 1985**

Every region of the world now reports at least one AIDS case.

**MARCH 1985**

First HIV antibody test is approved for use in the U.S. Screening of the nation's blood supply begins.

**MARCH 1987**

First antiretroviral AIDS drug—azidothymidine, or AZT—is approved for use in the U.S.

**1991**

Looped red ribbon becomes the international symbol for AIDS awareness.

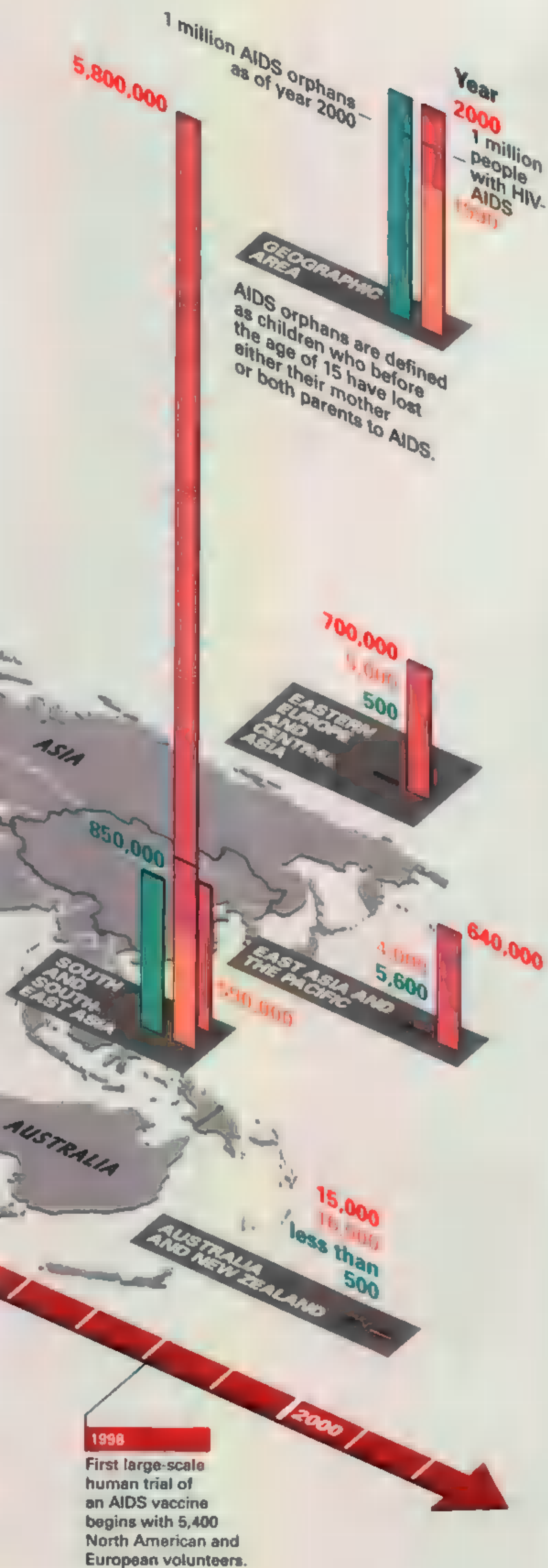
**1994**

AIDS becomes the leading cause of death for people in the U.S. between the ages of 25 and 44.

**1995**

Outbreak of HIV is reported among intravenous drug users in Eastern Europe.

In two decades AIDS has killed more than 20 million people worldwide. As infection rates have soared, so has the annual death toll. The disease claimed three million, most in their prime, in the year 2000 alone. Children left as orphans and jobs left vacant are now crippling burdens in the countries with the largest losses.



SOURCE: UNAIDS  
NATIONAL GEOGRAPHIC MAPS

team that contributed to the discovery of HIV in 1984. But we still don't understand exactly how the virus causes disease.

HIV seems full of contradictions. It can overwhelm the human immune system, yet the virus itself is fragile. Cold viruses linger on hands, and sometimes for days on doorknobs, but fresh air dries and destabilizes HIV in hours or even minutes. Contact with rubbing alcohol or chlorinated water quickly renders it inactive. Simple bar soap neutralizes HIV by breaking the chemical bonds of its lipids, or fats. And because so few cases of oral transmission have been documented, doctors conclude that the same antiviral compounds in saliva and stomach acids that protect us from a host of germs prove very effective against HIV in low concentrations.

Once a person is infected with HIV, however, the virus attacks the very immune cells, called T cells, meant to fight it. "Think about trying to invade a fortress," said Gary Nabel, director of NIH's Vaccine Research Center. "Would you start by setting off a grenade in front? No. You would sneak in quietly, penetrate the nucleus, and sit there. You'd clone yourself. You'd make lots of copies. Then, when an opportune occasion came along, when there was a lot of commotion and people were distracted, you'd say, 'Boom! Here I go.'

"That's what HIV does. That's what has allowed it to become so successful from its perspective and so tragic from ours," said Nabel. During a period of typically eight to ten years HIV lurks in the body, mutating rapidly and thus avoiding recognition. It reproduces massively, and waits. Finally, at the introduction of a disease that an unimpaired immune system would normally control—tuberculosis or pneumonia, for example—the immune system is overcome by HIV so that it cannot fight, and the disease kills.

"NINETEEN NINETY-SIX was the year the thunder came," Igor Ivanov said, and "the Russians heard it, and they crossed themselves."

Ivanov, a doctor at the Kaliningrad Regional Infectious Hospital, was referring to the year HIV cut loose in Russia amid the chaos of a collapsing economy. Unemployment shot up, and with it alcoholism and crime. Drug dealers began to create a heroin market in Russia.

Through shared needles, HIV reached far beyond its African origins into a country that during Soviet times had tightly controlled what crossed its borders.

"I got HIV by using a friend's syringe," said Dennis, 22, a patient at the Anti-AIDS Center in the Kaliningrad hospital. "I was 14 when I started shooting. I had no idea of the risks. It was cool. It was in fashion." Dennis stood tall with broad shoulders and red hair. He wasn't sick yet but claimed he had been suffering chest pains. "Now my friends are gone," he continued. "They don't want to shake my hand. My only friends now are HIV-positives."

"We knew we were on the edge in 1995," said Tatiana Nikitina, chief doctor at the Anti-AIDS Center. The region already suffered Russia's highest rates of syphilis and hepatitis. Prostitution, common to many port cities, complicated the picture. "AIDS started to spread not only among men but among women too, as drugs and prostitution are linked," said Nikitina. "It's all connected to the period when the free market made many things available for the first time, including drugs."

If 1996 brought AIDS to Russia, the same year saw the advent in the West of protease inhibitors, drugs that suppress the ability of HIV to replicate.

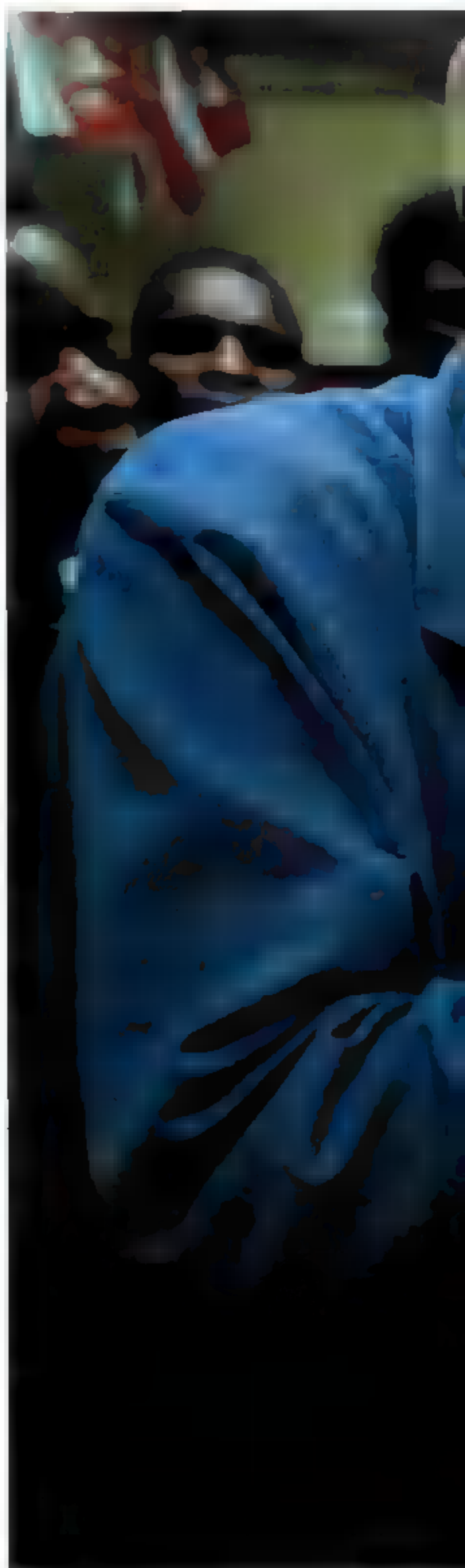
But protease inhibitors, often combined with other HIV drugs such as AZT, are far from prevention or cure. Their effects lift the death sentence of an HIV infection only for a time. Furthermore, they cost as much as \$15,000 a year, with huge drug-company profit margins, making them affordable in the U.S. and Europe but generally out of reach in developing nations.

In 1998 the Brazilian government began to produce and distribute copies of brand-name AIDS drugs using loopholes in international trade patents held by American and European pharmaceutical companies. Brazil's model has cut the death rate from AIDS in that country by half and stabilized the growth rate for new infections. Recent World Trade Organization negotiations

#### **LEARNING THE FACTS OF LIFE**

Leaving nothing to the imagination, a demonstration by AIDS-awareness volunteers of how to use a condom provokes a frank discussion about safe sex at a bar in Francistown, Botswana. With almost 20 percent of its population infected with HIV and with at least one baby born with HIV each hour, Botswana has begun an aggressive prevention campaign.

Feeding her baby formula provided by the Botswana government helps keep an infected mother (below) from passing on the virus through her breast milk. Free drug therapy reduced the risk of







transmission while she was pregnant.

Also ravaged by the disease, Thailand has taken drastic steps to slow its spread. Soldiers learn about AIDS by grim example as they view a victim's body at a hospice run by a Buddhist monastery.





"It's a full-time job, being an AIDS patient," says W. Maxwell Lawton (below), a Washington, D.C., artist who gives himself a testosterone injection once a week to help maintain muscle mass. Every day he follows a strict schedule, taking more than 20 pills between periods of fasting. Ten years ago he was so sick doctors gave him only three months to live. After participating in successful drug

trials, he hopes he will live to see a cure. "There's always hope," he says. "The human spirit will find it somewhere."

In Franceville, Gabon, Paul Telfer of New York University takes hair and blood samples from a pet chimpanzee (left). "A thorough understanding of the HIV viral evolution from its nonhuman primate origin to its current pandemic will help us create more sensitive tests and also

contribute to vaccine development," he explains.

The first large-scale vaccine trial in a developing country began in Thailand in 1999 among drug addicts like this volunteer receiving one of seven injections (left, middle).

Last May the 16th annual AIDS Walk in New York City attracted 40,000 participants and raised 4.5 million dollars to fund social services for people living with HIV/AIDS.





pointed toward increased low-cost availability of AIDS drugs in other developing nations.

While drug therapy results are promising, the use of protease inhibitors and other antivirals, such as AZT, can produce grave side effects that include nausea, bone loss, diabetes, liver damage, raised cholesterol levels, and depression. And doctors do not yet understand why HIV drugs rearrange fat in the body. The face becomes sunken and the limbs wizened while fat piles up elsewhere. To see the bulging belly and the humped back of a patient who has taken antivirals for several years only underscores the need to find another way to inhibit HIV.

“Historically vaccines are the only way to stop an epidemic,” said Dr. Peggy Johnston,

assistant director for AIDS vaccines at NIH. “But while a vaccine used as a public health tool might slow an epidemic or prevent one from starting, so far vaccines have not helped sick people.”

Lusaka, Zambia, is a city where the worst-case AIDS scenario is coming true—HIV has infected one in three adults. There I met Evans Ganzini Banda, a clean-cut Zambian in his late 20s. Not long ago Banda became one of 650,000 people to have lost both parents to AIDS in this country where, like many countries in sub-Saharan Africa, widespread prostitution and multiple sexual partners are common.

Faced with the expense of supporting five sisters, Banda founded a newspaper called



### THE NEXT GENERATION

**A crowd of children in Uganda are the offspring of two brothers and their several wives. One brother has AIDS. He has probably infected his wives, who may have passed the illness on during pregnancy to some of their children. No one knows for sure because HIV tests are not available in this village.**

**This one man's children may become AIDS orphans. Yet as they and their cousins grow up, they will almost surely benefit from the national sex-education campaign that has nearly halved the prevalence of HIV among adults in Uganda—one successful strike against a cruel foe.**

*Trend Setters*, which prints frank articles about the risks of HIV and other sexually transmitted diseases. As further illustration of Lusaka's plight, he ushered me into a taxi one Saturday night for a very uncomfortable exercise.

"The nightclubs are where AIDS is happening," he said as we toured the city.

We pulled up in front of one such club, a cinder-block structure with a corrugated steel roof. A group of teenage girls clustered at the car window. One of them, a gangly adolescent in beat-up high heels and a miniskirt, introduced herself as Adrina and slid into the car.

"How much?" asked Banda.

"It depends on what you want."

He told her.

"Thirty thousand kwacha [about ten U.S. dollars]," she said. "With condom."

"How much without?" asked Banda.

She shook her head.

"Why not?" he asked.

"AIDS," she said.

Banda pressed: "OK, 60,000 kwacha, without condom."

She hesitated, then answered: "A hundred thousand, without."

Banda looked at me. We had found the value of a life here—about \$33.

We told Adrina we were actually taking a survey and asked her why she would risk her life. She said she had no other way to make money for the coming week. She was trying to save \$125 to start a business selling secondhand clothes imported from the U.K. In the meantime she had one commodity to sell.

We gave her some money, about twice what she could have expected from a typical customer. Banda implored her to go home. She climbed out of the car counting the cash, leaving us pessimistic about her chances.

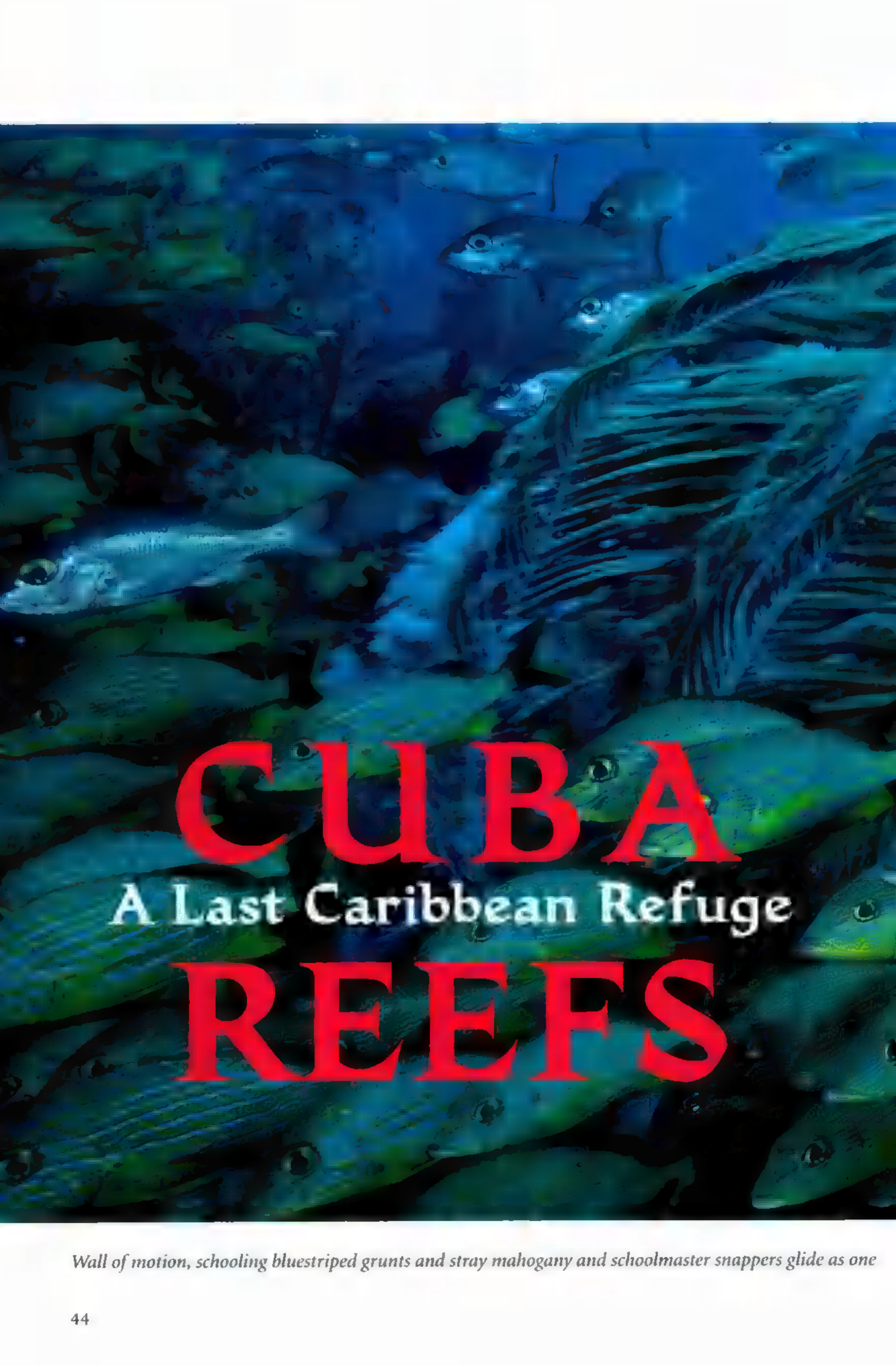
**O**N A RAINY WINTER DAY on the NIH campus back in the U.S., the Vaccine Research Center's Gary Nabel summed it up thus: "The problems of the developing world are our problems too. We're already dealing with more than 36 million incubators walking around with this virus, spreading it to other people. And it's got enormous abilities for adapting to new niches."

Clearly, what causes AIDS and what causes an AIDS pandemic are two very different, intractable problems. But the words I'd heard about vaccines from Peggy Johnston at NIH rang true. A future vaccine will not cure Dennis, already infected with HIV, and offers little hope for Adrina or the Thai man at Clinic 17, in danger of becoming infected soon. But a vaccine might someday make a difference for people like them, for their countries, for the world. Until that day arrives, the AIDS crisis will continue to rampage through developing nations with unpredictable consequences for the future of all humankind. □

#### ▶ MORE ON OUR WEBSITE

Learn more about progress in the worldwide fight against HIV/AIDS at [nationalgeographic.com/ngm/0202](http://nationalgeographic.com/ngm/0202).

AOL Keyword: NatGeoMag



# CUBA

A Last Caribbean Refuge

# REEFS

*Wall of motion, schooling bluestriped grunts and stray mahogany and schoolmaster snappers glide as one*



HAEMULON SCIURUS (SCHOOL); LUTJANUS MAHOGONI (SCHOOL); LUTJANUS APODUS (YELLOW TAIL)

*through Caribbean waters off southern Cuba—a nearly unspoiled oasis of living, flowing color.*



*OGCOEPHALUS NASUTUS*



*Submarine sensors: A lure hidden in a batfish's proboscis (left) attracts tiny swimmers and senses their*





CARCHARHINUS FALCIFORMIS

*proximity. Pits in the silky shark's snout (above) read electromagnetic signals from potential meals.*

BY PETER BENCHLEY

PHOTOGRAPHS BY DAVID DOUBILET

# **I T WAS ALMOST LIKE A HALLUCINATION. IMMEDIATE. A SENSE OF DISLOCATION. SOMETHING WAS AWRY.**

A few seconds earlier, seen from the surface, everything had looked normal. The midday sun shot arrows of light through the dappled water, illuminating a routine reef in an isolated backwater of an exhausted sea. But no sooner had I submerged—my bubbles had had no time to disperse nor the mist to clear from my mask—than I knew I was in the grip of the weird.

Time was out of joint.

I had flopped overboard from a dinghy on a glassy Caribbean sea in the summer of the year 2000 and in an instant, apparently, slipped backward nearly half a century into an underwater realm that had not existed, so far as I knew, since the 1950s.

Residents swarmed over me, welcoming me to the neighborhood, animals in numbers and diversity I hadn't seen in decades, not since Lyndon Johnson was President and man had yet to set foot on the moon. Groupers of all descriptions and sizes lumbered around me: Nassau groupers, black groupers, even the patriarch of the grouper clan, the gigantic jewfish (aka the goliath grouper), creatures widely assumed to have almost disappeared from the Caribbean long ago—speared, hooked, netted, poisoned by men driven by poverty, hunger, and need.

Schools of yellowtail snappers and blue creole wrasses darted about in a frenzy, then quickly departed, their curiosity sated.

A squadron of glittering silver tarpon passed regally by, implacable eyes showing neither interest nor alarm.

Green moray eels slid partway out of their crevice homes, needle-toothed jaws mimicking menace as, rhythmically, they pumped oxygen-bearing water over their throbbing gills.

In the middle distance reef sharks scanned the coral for signs of wound or weakness,

having appraised and dismissed me as worthy of neither fearing nor eating.

Nearer came a big, robust bull shark—pregnant, swimming close enough to let me feel the pressure wave of her passing, as if shouldering me aside.

I settled to the bottom and spun in a slow circle, my eyes searching every corner of this peaceable kingdom. Pairs of jacks tumbled along the reef line, squabbling, it seemed, or playing, but in fact breeding, as evidenced by tiny puffs of white that emerged from the commotion: eggs conjoined with sperm.

Fifty or sixty feet above, a pair of turtles swam locked together, one atop the other, snouts out of water . . . mating.

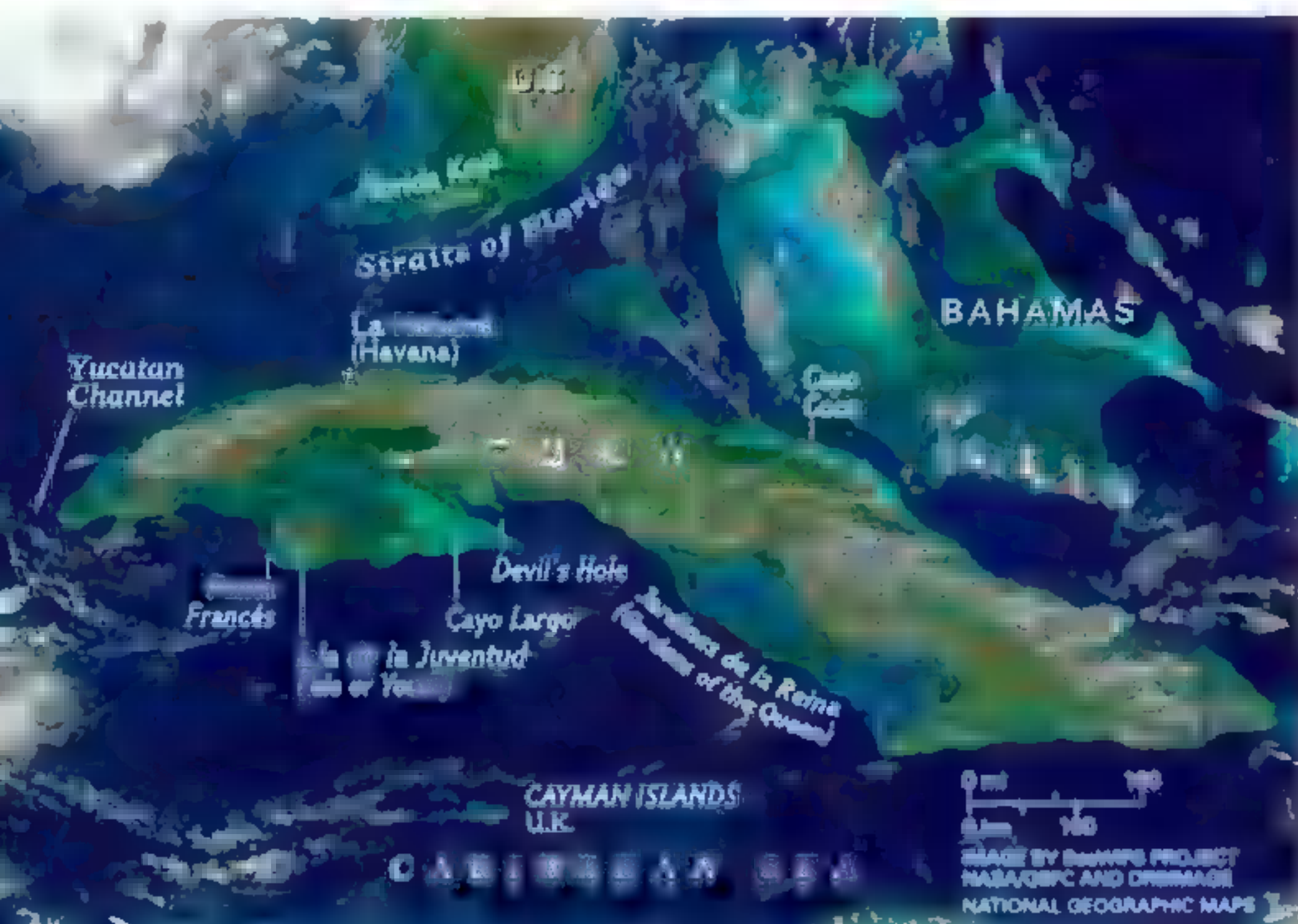
For an hour or more I luxuriated in this astonishing replay of halcyon days and cherished memories. Then, low on air, I surfaced. Photographer David Doubilet, who has either (as I suspect) grown gills from spending 45 years underwater or (as he claims) learned to draw breath only once every few weeks, stayed below capturing images to prove that these wonderful creatures, relics of happier, healthier times in the sea, still did, indeed, exist.

That they do exist—or, more accurately, that they could continue to survive and reproduce amid the shameful devastation of most of the surrounding sea—was thanks to an unlikely combination of factors: autocracy, bureaucracy, paucity, wisdom, ingenuity, dogged persistence in the face of a lonely ideology, and, finally, common sense . . . all of which are characteristic of the constantly changing enigma that is Cuba.

I was well aware that these particular paradisiacal waters were neither common nor typical. Cuba has more than 3,000 miles of coastline, four primary reef systems (each of



Ascending coral cliffs in a spotlight, free-diving champion Deborah Andollo of Cuba practices her skills in Devil's Hole. One breath takes her to 133 feet with ease (her world record is 243 feet) before she soars upward for air. "The cliff walls watch me go by," she says, "miraculously secrets of how to do it better."



## CUBAN ISLES

With the largest submerged shelf of all Caribbean islands, Cuba—including its four archipelagoes and myriad bays, cays, mangrove forests, and reefs—sustains astonishing marine biodiversity. Despite some shoreline development, such as hotels on Cayo Largo (center island in satellite view at right), many reefs remain nearly unscathed—far from land, pollution, and progress.

which is about equal to or longer than the Florida Keys), and more than 4,000 islands, islets, cays, humps, lumps, and spits. From conversations with Cuban scientists and environmentalists who have been working for more than ten years to develop a comprehensive, sustainable marine conservation program, I knew that many of the reefs were severely stressed.

“We’re beginning to see serious damage from coastal development and overfishing,” one scientist told me. “But look: We’re a population of 11 million people, and we have to struggle for everything we get. There’s only so much we can protect.”

Among the areas that *are* being protected is a patch off Cuba’s southeast coast of roughly a thousand square miles of reefs, mangrove swamps, and islands unnamed and named—Cayo Caballones, Cayo Cachiboca, Laguna de Boca de Guano, and so on—that is known collectively as Jardines de la Reina, or the Gardens of the Queen. It is a sedulously guarded marine sanctuary, off-limits to all but a few Cuban lobster boats and a handful of foreign divers and light-tackle fishermen.

Too far from land (50 miles) to be accessible to most local commercial fishers and protected by strictly enforced government laws against poaching, the Gardens of the Queen had been allowed to flourish almost entirely free from human assault.

Still, distance and regulations alone could not be relied upon to deter the desperate, and

the gardens were further sheltered by a public-private joint venture between the Cuban government and an Italian company named Avalon. The company had a license to operate a substantial catch-and-release fishing camp called La Tortuga from a floating hotel moored in the labyrinthine canals among the mangrove swamps. It shared its profits with the Cuban Ministry of Tourism, and its 20 small fishing boats were always on the water, carrying one or two of the hotel’s 25 weekly guests to or from a fishing spot. They were a constantly vigilant presence.

“We bring our guests every day to every corner of the gardens,” Giuseppe (Pepe) Omegna, resident manager of La Tortuga, told me. “We have the finest fly-fishing in the world for bonefish, tarpon, and permit, so obviously it is in our interest that nobody affects the area. We cooperate fully with the border police and the fishing authorities to take care of this paradise. We never leave the gardens.”

If the Gardens of the Queen could be preserved in their natural state while at the same time be opened to carefully monitored groups of visitors, the thought occurred to me, they could become a template for sound development and a significant contributor to the chaotic Cuban economy.

When I returned to our boat, the 110-foot *Ocean Diver*, I was greeted by Manuel Mola, a tough, compact dive master who had been assigned to us by the Cuban government

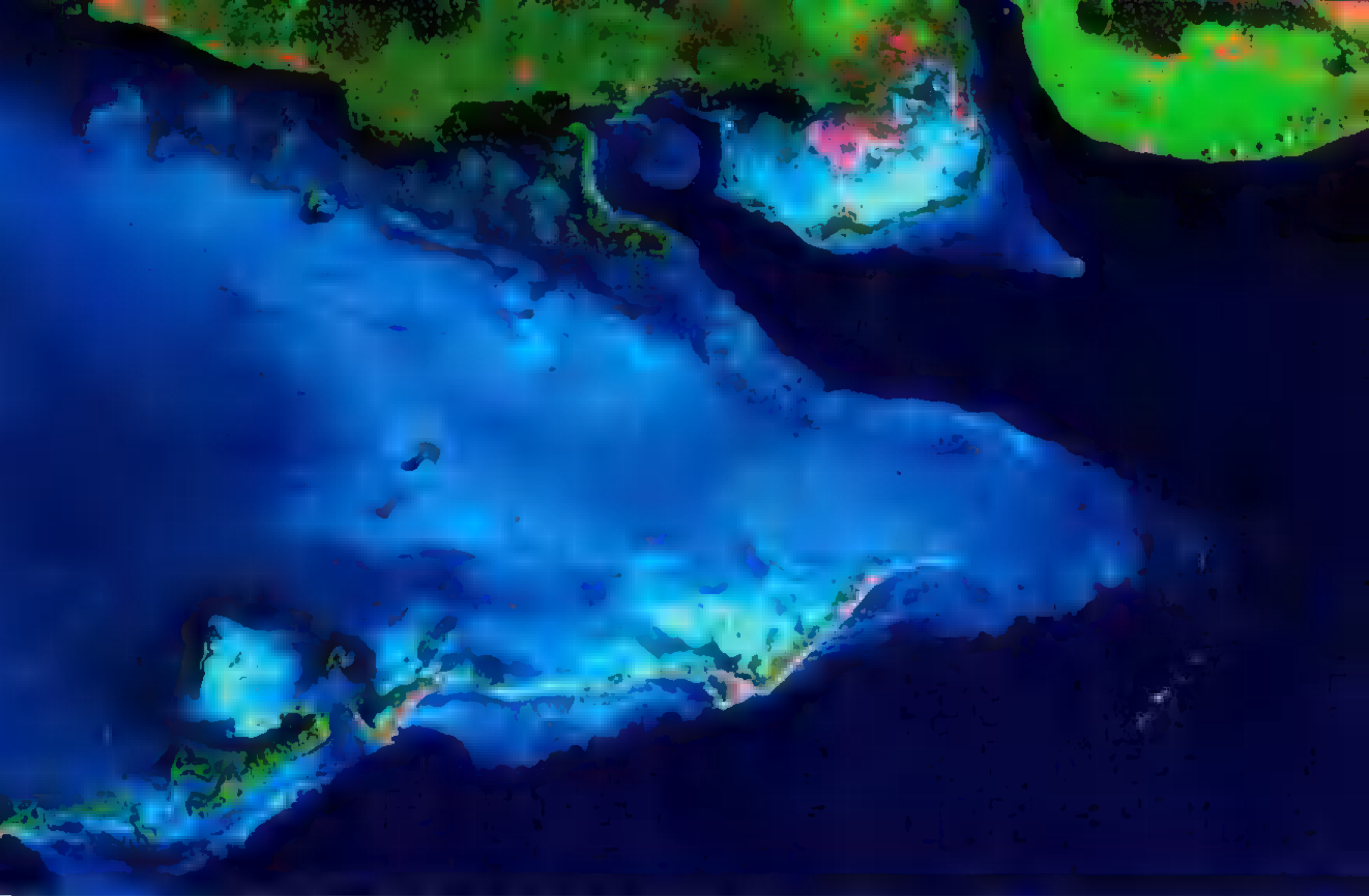


IMAGE PROCESSING BY SERGE ANDREFOUF, UNIVERSITY OF SOUTH FLORIDA, ST. PETERSBURG. PHILIP KRAMER, UNIVERSITY OF MIAMI

(nominally the Ministry of Tourism) as guide, adviser, and . . . well, let's be frank . . . minder.

"You see now why we always argue with the Ministry of Fisheries," he said with a grin. "They tell us how much fish are worth to the fishermen and their families. We tell them how much more the fish can bring in if they're left alive."

The conflict implicit in Manuel's remark—the value of fish as commercial product versus the value of all marine creatures as tourist attractions—reflected a change ongoing throughout Cuba. At a time when tourism is seen as the salvation of the Cuban economy, scientists within and without the government are struggling to balance the demands of growth with the need for preservation.

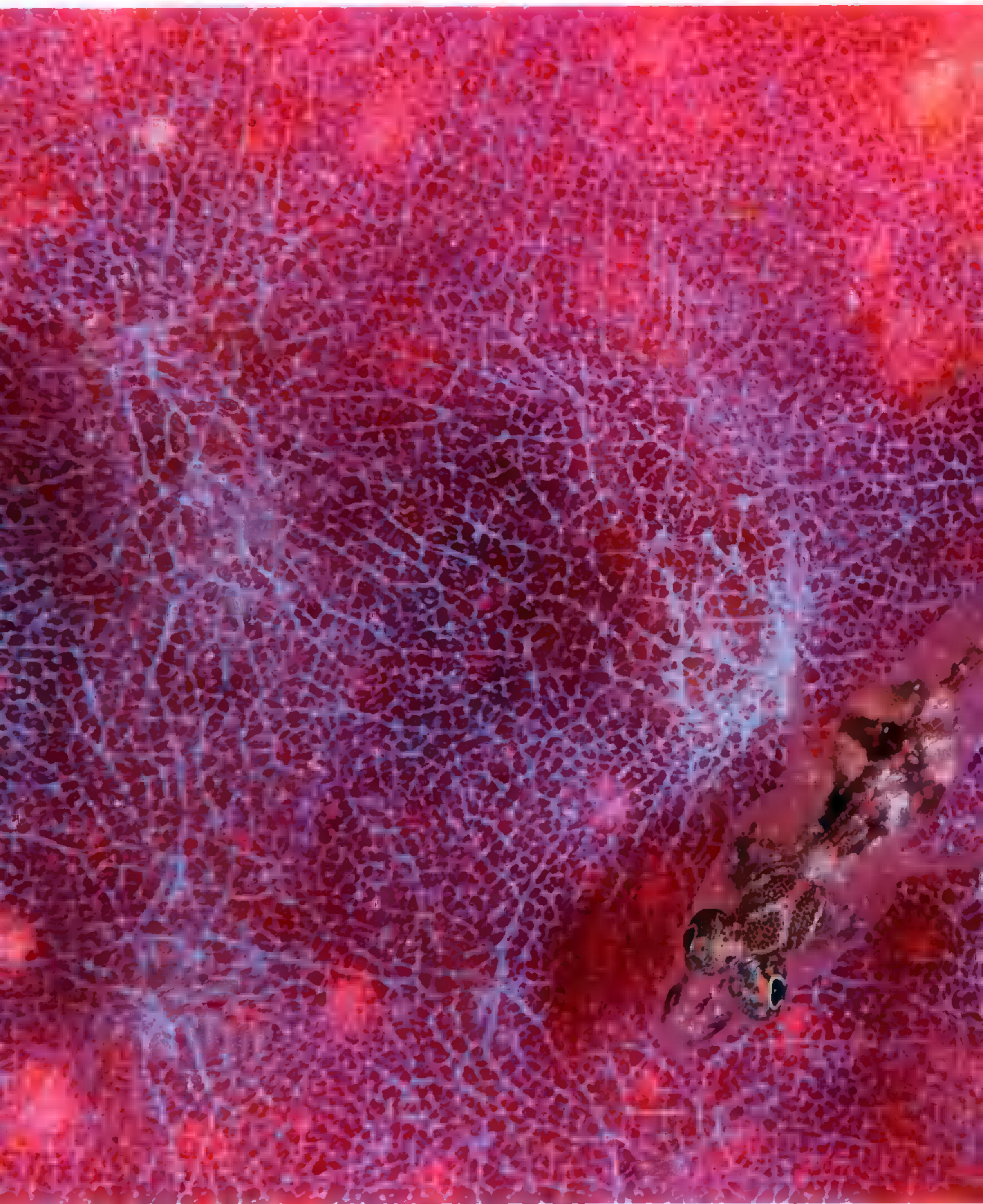
The island nation already receives more than two million visitors a year, and the government has ambitions to welcome more than five million foreigners annually by 2005. Gigantic hotels are bursting forth like mushrooms upon the shorelines. Aided by mammoth infusions of European cash, Old Havana is being lovingly, expertly, and splendidly restored, its colonial-era buildings supplied with all the modern amenities—from air-conditioning to Internet access—necessary to attract 21st-century businesses and visitors.

**T**HE CUBAN GOVERNMENT knows full well that in the tough competition for the global tourist dollar, environmental sensitivity is a valuable commodity.

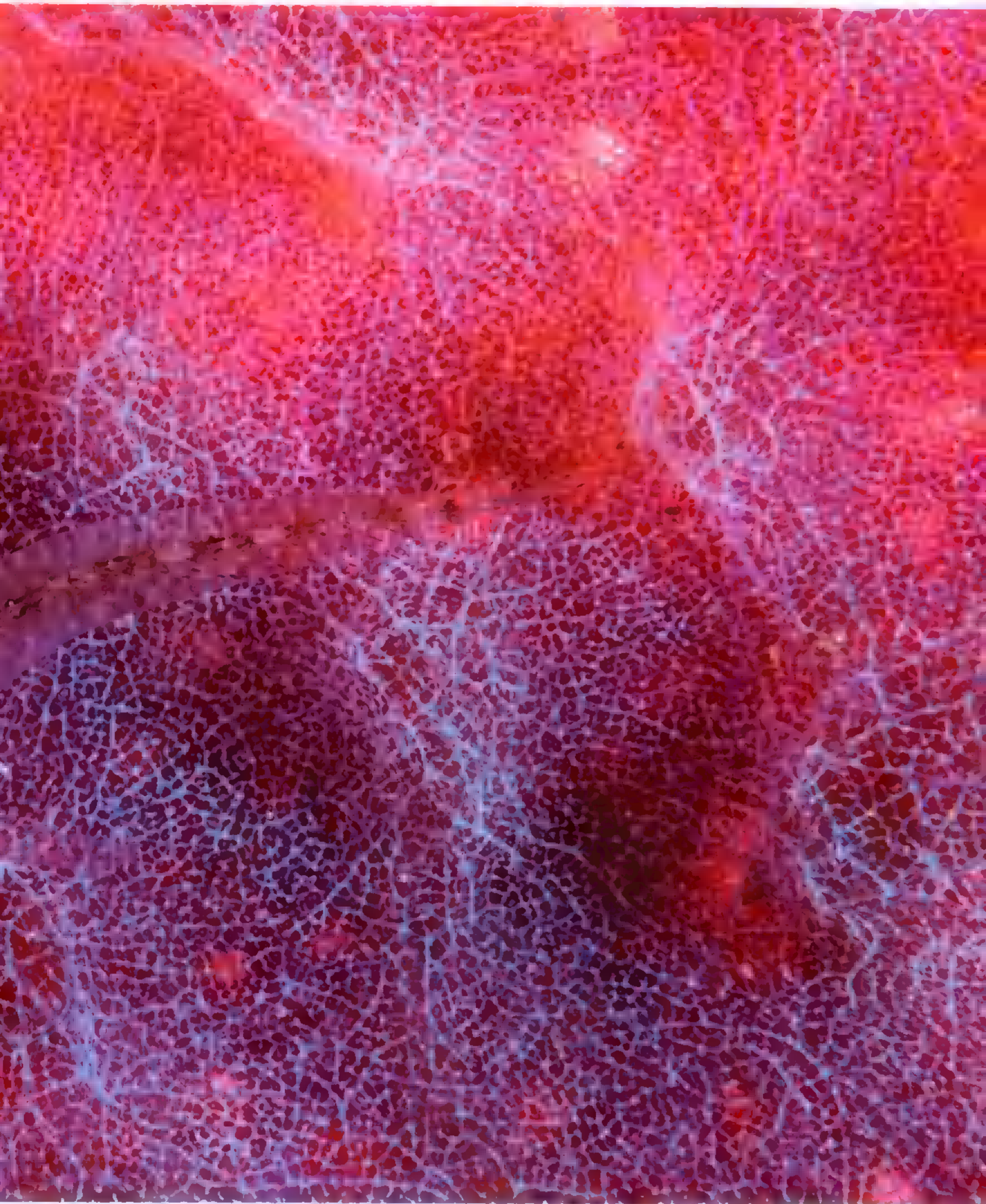
I met one day with Rosa Elena Simeón, Cuba's minister of science, environment, and technology, in her cavernous office in the classic capitol building in Old Havana. A grandmotherly woman with eyes of burnished steel, Minister Simeón admitted that toughness was part of her mandate.

"Laws are only as good as their enforcement," she said. "We must be strict. We'll shut down any hotel, any factory, any investment opportunity that violates our environmental laws." She smiled knowingly and added, "Of course, we can be stricter. The control we have permits the maintenance of order." So, I noticed, did the size of her staff. Her young ministry, begun only in 1994, was now composed of 40 entities employing 9,000 people, including, she said proudly, "more than 350 Ph.D.'s."

Outside Old Havana, in a quiet residential neighborhood, María Elena Ibarra Martín, director of the Center of Marine Studies at the University of Havana, was, if anything, more direct than Minister Simeón in articulating her government's commitment to marine conservation.

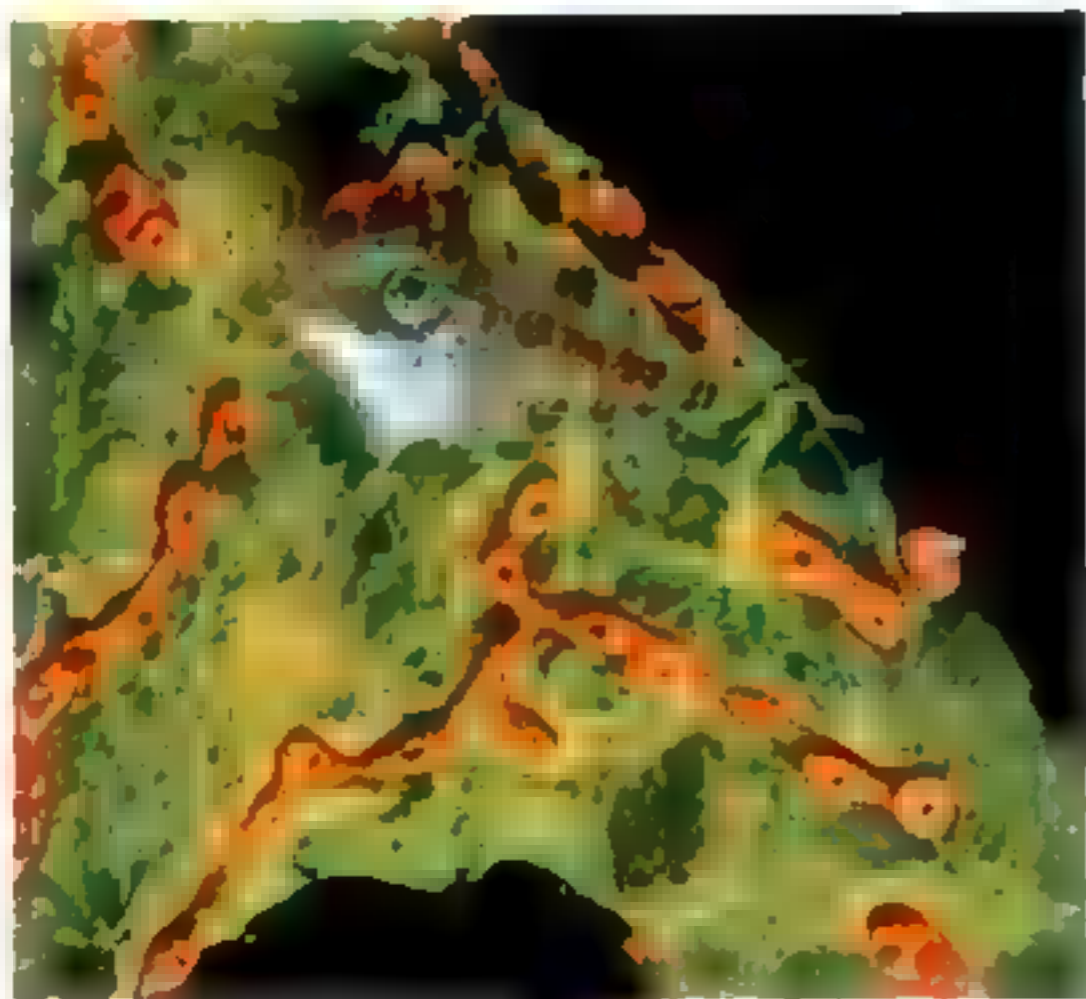


*Lit from within by the photographer's flash, a vase sponge hides a slender fish with roving eyes. About an*



DEMOSPONGIAE (SPONGE)

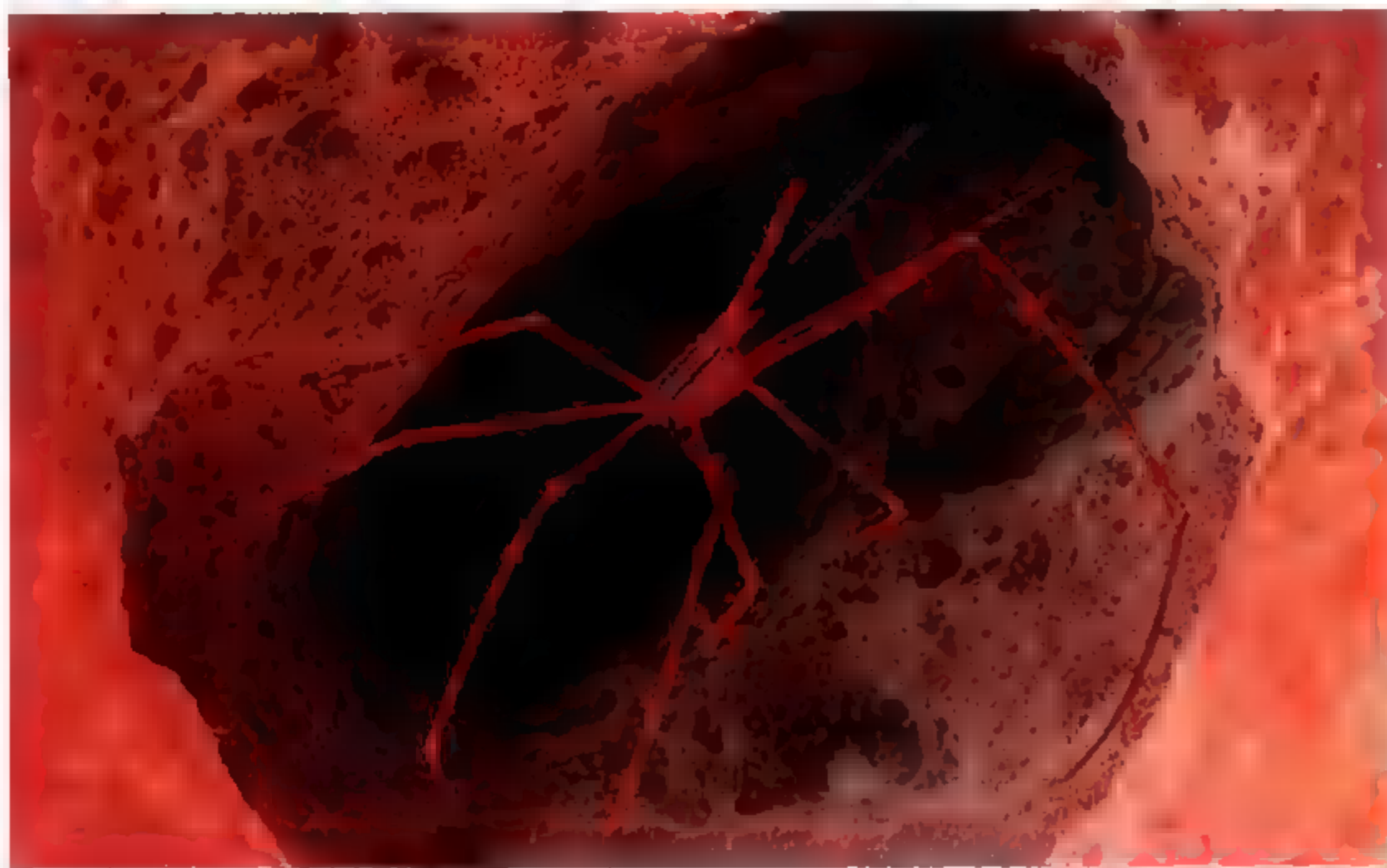
*inch long, the fish perches unmoving, then darts from its rosy host to feed and returns quickly to safety.*



MONACANTHUS SP. (FILEFISH)

## SPONGE LIFE

Ancient metazoans clinging to undersea walls, sponges provide feeding grounds and cover for a juvenile filefish (left) and arrow crab (below) in the Gardens of the Queen (right). "Cousteau compared sponge gardens to Ali Baba's cave," says photographer David Doubilet, "secret caverns filled with jewels of the Earth."



STENORHYNCHUS SETICORNIS



"Because the government controls all levels of activity," she said, "implementation of order is easier than in other Caribbean countries. There is not much violation of our laws. As a result our marine environment is in better condition than elsewhere."

Cuba has another curious advantage over the rest of the Caribbean's island nations: Because of its political isolation, it lags more than 40 years behind in terms of massive tourism development and the concomitant destruction of marine life and habitat.

"Cuba can still be saved," I was assured by Ken Lindeman, a senior scientist with Environmental Defense who has worked in Cuba for seven years. "But there's not much time. There will have to be other sanctuaries as well protected as the Gardens of the Queen."

Indeed, the *Chronicle of Cuban Marine Fisheries*, published by the Food and Agriculture Organization of the United Nations, documents drastic decreases in the landings of

certain species since the beginning of the 1990s. The chronicle concludes that "87.6 percent of fisheries resources are in a critical stage," with declines of 95 percent and 88 percent respectively in landings of Nassau groupers and mullet. Furthermore, development both on the shorelines and far inshore (dams, logging) is reducing nursery habitats for a great many marine creatures.

I had heard no tales of damage done by increased tourism, but I looked forward to seeing for myself.

I had joined *Ocean Diver* at Cayo Largo off Cuba's southwest shore, just to the east of the Isle of Youth, and my first dive was at a site known as Devil's Hole. Diving tourism is by no means a novelty in Cuba. Some popular, accessible sites, like Punta Francés off the Isle of Youth, attract as many as 30,000 divers a year. Devil's Hole had been brazenly promoted in tourist brochures, and I wondered if it would live up to the puffery.





The attraction eluded me, however, because as far as I could see, there was no *there* there. The charms of Devil's Hole were reserved for macro-photographers, whose trained eyes and special lenses could capture the minuscule life forms on the coral walls and within the countless sponges.

**A**S WE MOTORED EAST toward the Gardens of the Queen, we encountered no other dive boats and only one or two small fishing boats. "Very few licenses, very little fuel," one of the crew told me quietly, trusting me to extrapolate: The Cuban government was carefully restricting and monitoring all seagoing traffic, wary of the ambitious captain who might be tempted to take his boat and all its gear, plus his family and friends and even, perhaps, a few paying passengers, on the journey across the Straits of Florida to the promise of asylum in the United States.

We did meet some mariners, though, who had managed to carve out livings for

themselves within the maze of restrictions.

One morning our boat was approached by a large, ramshackle motor vessel that looked as if it had been at sea since Noah was a boy. The water was flat calm, so the two boats rested easily side by side a few feet from one another while representatives of the two crews carried on serious, sotto voce (but utterly cordial) negotiations. The result: Our boat acquired more than a dozen fresh lobsters in return for a bottle of rum, half a pound of coffee, four rolls of toilet paper, a few packets of powdered soft drink, and (our captain added proudly, as if these were the items that had sealed the deal) "two used spark plugs."

"All Cubans are ingenious," he said as he watched the lobster boat pull away. "They have to be. Ashore these men will get so little for their lobsters that they can't support themselves, even though by the time the lobsters land on the tourists' tables, they'll fetch maybe \$500. So these guys stay at sea; they eat what



they catch and barter for what they need. Above all, Cubans are survivors.”

Time and again members of our crew proved him right. Several had advanced degrees: Irumis, our cook, was a veterinarian; Annie, the maid, had a master’s in education. Ashore, in their professions, they might make the peso equivalent of between \$10 and \$15 a month. Their salaries on the boat were roughly the same, but here there was always the chance of tips in precious U.S. dollars.

And there were occasions for freelancing. Every morning and evening from our anchorages on the mudflats we could see dozens, scores, maybe even hundreds of large brown rodents foraging on the beaches of the tiny

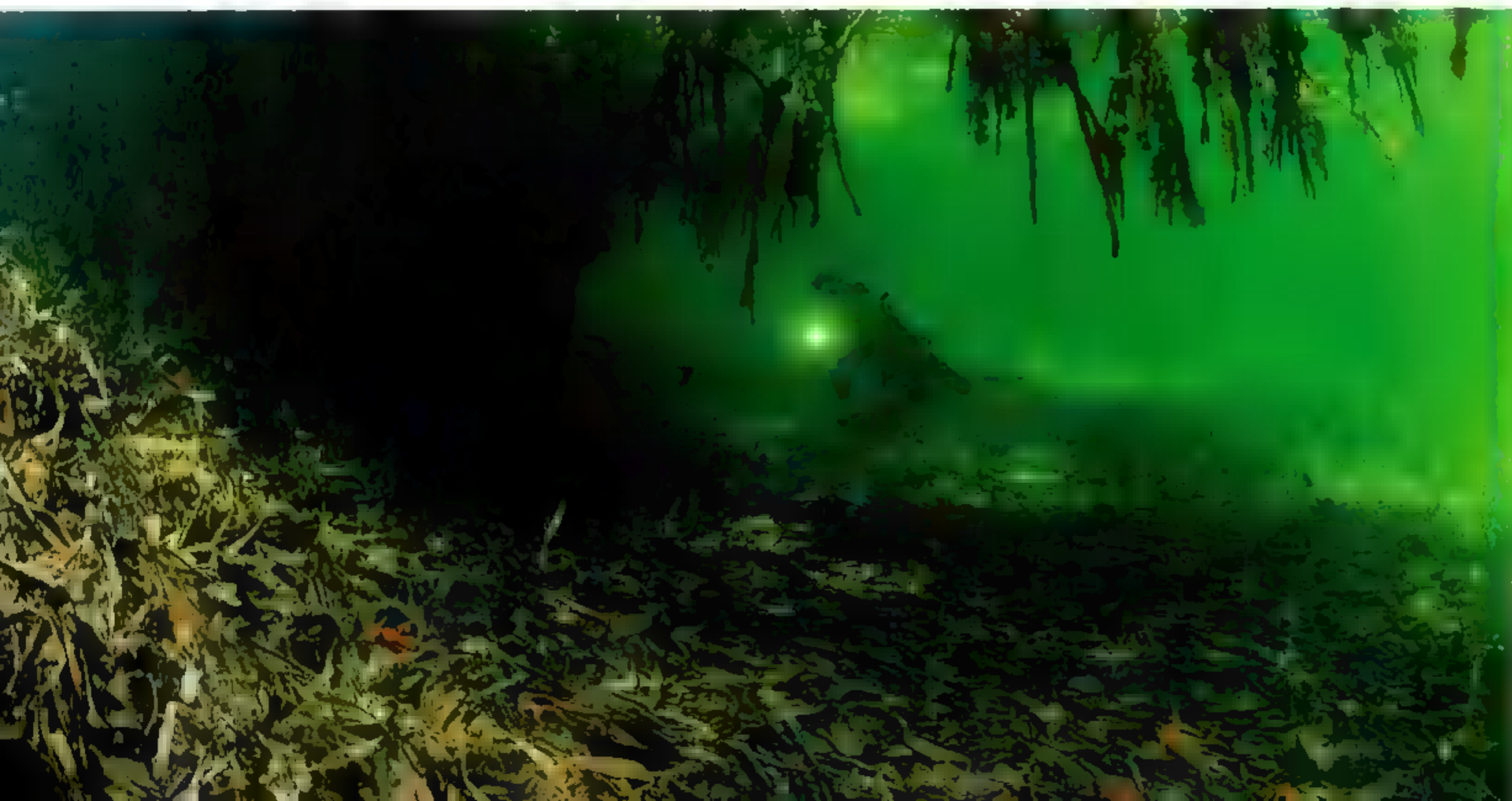
islands or scampering through the mangroves.

“*Jutias*,” explained one of the young crewmen. “They’re a kind of tree rat.” He paused, then added with a smile: “The government keeps them here in case of war.”

“As what?” I asked. “Biological weapons?”

“Food,” he replied tolerantly. “Cuba is always prepared for war. The trouble is, *jutias* have no natural enemies around here except crocodiles, and they’re eating themselves out of habitat.”

The crewman was always willing to restore nature’s balance and coincidentally, of course, to acquire a stock of scarce animal protein. Frequently he would go ashore in the twilight of morning or evening, dressed only in a bathing suit and scuba booties and carrying





CROCODYLUS ACUTUS

## AT HOME AMONG THE MANGROVES

*Undulating through a sunlit sea, an American crocodile heads toward the nutrient-rich feeding grounds of mangrove forests that line Cuba's southwest coast. Formed by tidal ebb and flow and walled with tangled roots, shallow mangrove channels (below left) wind like rivers through the trees, their floors carpeted with fallen leaves. Endless hideouts in the calm, murky waters—tinted tealike by dissolved organic matter—safeguard nurseries of juvenile reef fish.*

a machete. Nimble as a spider, he would vanish into a tangle of mangrove roots and branches and emerge, usually in under an hour, with three or four jutía carcasses swinging by their tails. Most he would skin, butcher, and freeze to give to his family; some he would share (unnecessarily generously, I thought) with us.

To my pampered palate, jutías were barely edible—slimy of texture and vile of flavor. But I, of course, had no firsthand knowledge of hunger or malnutrition. If I had, jutías might be as savory to me as veal.

The mangrove swamps that shelter jutías are vital organs in these marine ecosystems. They shelter, feed, and protect animals newborn, young, and vulnerable, and they filter the water that comes and goes on the tides. Though in the mangroves of the Gardens of the Queen we saw the inevitable signs of human intrusion—beer and soda cans, whiskey bottles, plastic spoons—mostly we saw healthy signs of burgeoning life: baby barracuda already swimming in the protection of schools; tiny, cylindrical tunicates dangling from underwater roots; infinitesimal shrimps and crabs. And somewhere in the rich and cloudy water, we knew,

were the fingerlings of the larger animals of the reefs: the jacks, the snappers, and the sharks.

**S**NORKELING through the mangroves early one morning, I watched a young stingray bury itself in the bottom, fluttering its wings in the silt until nothing was visible but the cartilaginous lumps over its eyes. Suddenly a rush of pain stopped my breath; my cheeks and neck felt assaulted by a million flaming needles. Quickly I retreated, scanning the murk for villains while trying foolishly and in vain to douse the feeling of fire by rubbing my face.

It took me a few moments to realize that the answer to the pain lay not in what I *could* see but in what I *couldn't*: microscopic poisonous harpoons, the stinging nematocysts of hidden *Cassiopea* jellyfish, released from their repose in the muck by the turmoil caused by the stingray's wings.

All perfectly normal, all quite painful.

One phenomenon we encountered with increasing frequency, however, was not only *not* familiar to me but quickly became troubling. And then, as corroborative reports reached us from more and more (Continued on page 66)

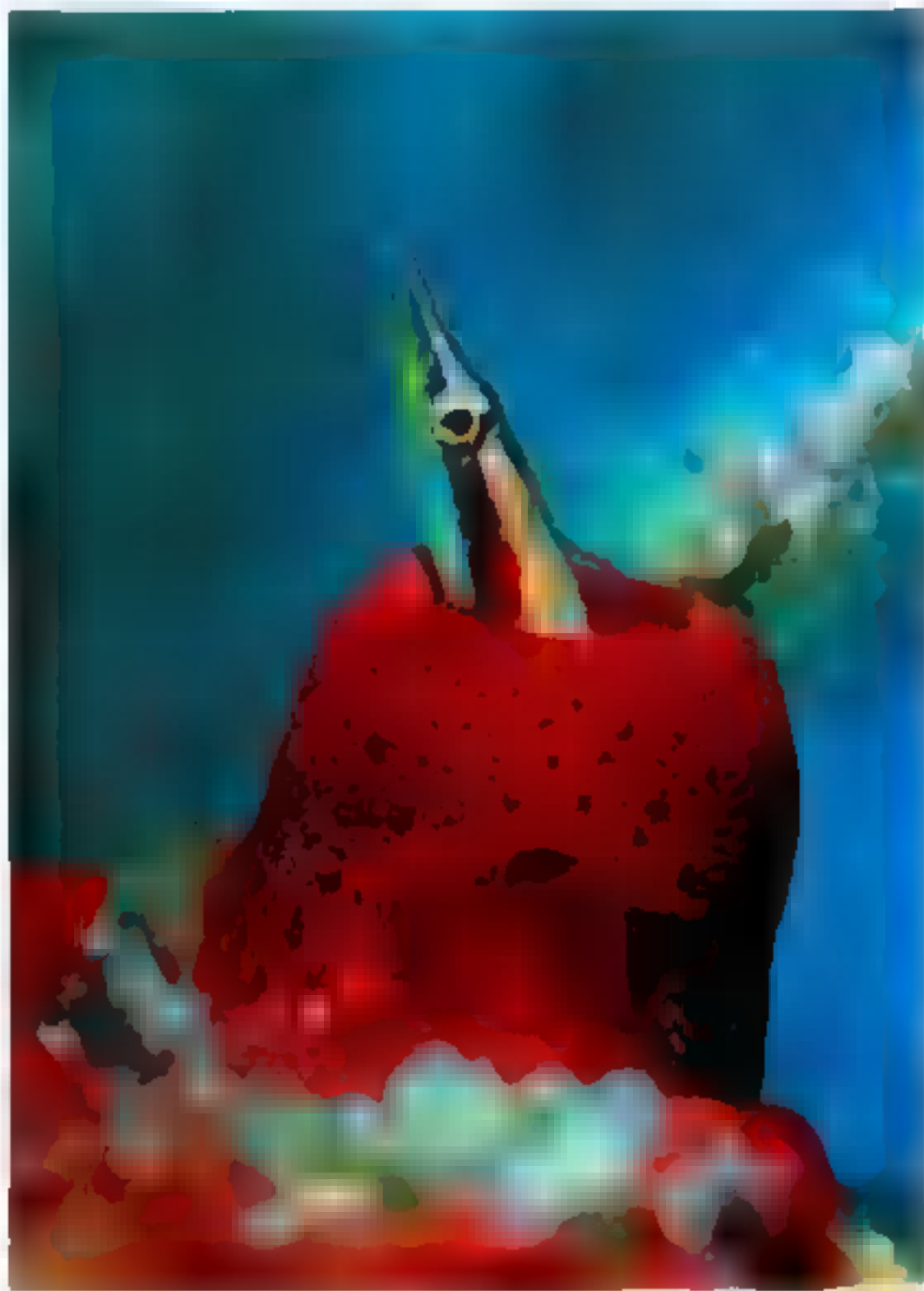
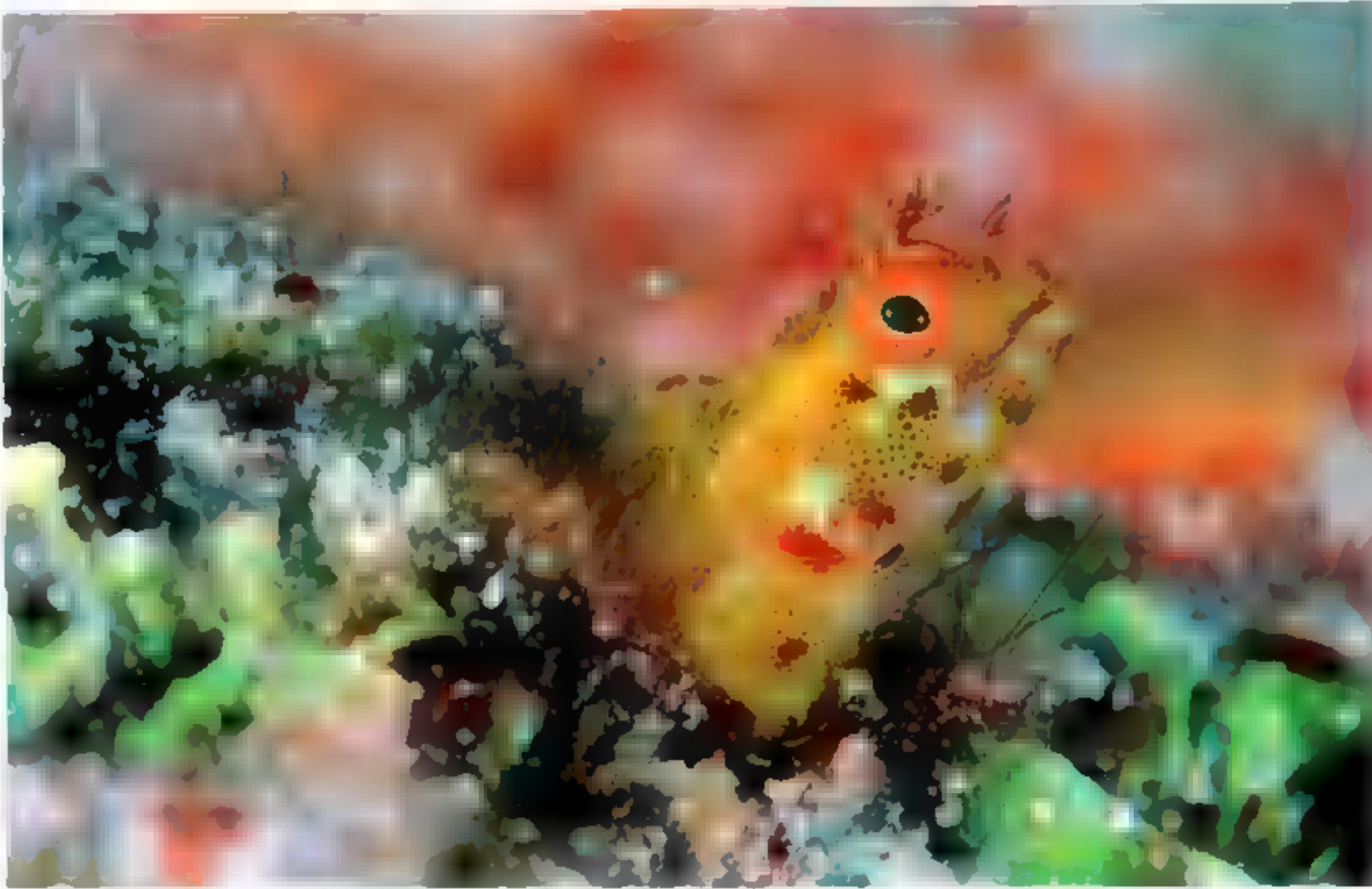




## WILD PROFILES

*It takes all types to cast the drama beneath the sea, here captured against a curtain of liquid blue. A gray angelfish (top left) is the epitome of underwater grace: a leisurely swimmer slipping silently between corals, nibbling at the sponges and polyps growing there. As though created by Dr. Seuss, the ever frowning shortnose batfish (left) is a cumbersome paddler better suited for lunging ahead froglike on the seafloor, where it jabs its snout into the sand and gobbles up mollusks and other edibles. A swifter mover, the reef squid (above) flies through water by jet propulsion, usually backward, and can change its hue to match its surroundings, which it surveys through a remarkably advanced pair of eyes.*

POMACANTHUS ARCUATUS (ANGELFISH), SEPIOTEUTHIS SEPIOIDEA (SQUID),  
OGCOCEPHALUS NASUTUS (BATFISH)



## NOOKED AND CRANNIED

*Like tiny finger puppets, blennies keep heads up and tails tucked into crevices or sponges. The secretary blenny (above) stays half out of danger until ready to rush at prey, while the arrow blenny (left) is often away from its shelter stalking fish and shrimps. A bandtooth conger's big eyes (below) greeted Doubilet as he peered into a sandy hole that was perfectly round—an uncommon sight in nature. “These eels are master excavators,” he says. Aptly named, a male yellowhead jawfish (right) uses his mouth to engineer his burrow—a walled underground chamber—and to protect his young. The jawful of caviar is not food but progeny, which he churns in his mouth to aid development.*

ACANTHEMBLEMARIA (SECRETARY BLENNY), LUCAYABLENNIUS ZINGARO (BLENNY);  
 (CONGER); OPSTOGNATHUS (JAWFISH)







*Silvery ghosts at twilight, silky sharks and yellowtail snappers feed on offerings from a dive boat. "It was*





CARCHARINUS FALCIFORMIS (SHARKS); OCYURUS CHRYSURUS (SNAPPERS)

wild," recalls Doubilet. "They would swim in circles, bump one another, turn, and fly the other way."



## CLEAR SURVIVORS

A light suspended from a boat off the Isle of Youth draws radiant visitors. These box jellyfish (right), unlike deadlier varieties, rarely kill humans though their sting is agonizing. More benign evening guests include a tiny post-larval surgeonfish (above), whose transparency turns it invisible to predators. The stunning biodiversity of a bygone era still thrives in Cuban waters. Says Doubilet, "It's like a memory preserved."



(Continued from page 59) places, it took an ominous turn. It goes by different names in different locales: In the Cayman Islands it is "sea itch," in Bermuda "sand fleas," in Florida "sea lice." Here in Cuba it is named after the Carib Indians, the fiercest of all the aboriginal residents. Cubans call it simply "Caribe."

I have no name for it, only a description: invisible, time-delayed, ambushing agony. It struck in shallow water or deep, on the bottom or at the surface, on the reef or in open water. It infiltrated any opening in mask or wet suit and, once within, would flood a human body with tiny, biting, burrowing, infesting, and infecting *monsters*.

First we all wore hoods and booties and gloves. Then, as they proved ineffectual, we swabbed petroleum jelly on all junctures of rubber and flesh. Finally we wrapped our ankles and wrists with waterproof tape.

And still they got us. I recall surfacing one day and turning back to take one of David's cameras from him, and as his head broke

water, I saw that every millimeter of exposed skin was swollen with pustular sores.

Was the villain a flea, a bug, a jellyfish, a larval state of something? I asked the captain and crew; I sought enlightenment from the boat's radio. I found no answer. It was Caribe. Period. It came every year with the warming of the water, and every year the water seemed to be warming earlier. Usually it did not strike until August or September, but this year . . . yes, the water on the surface was already nearly 90°F, and it was still only early June. But, we were told, that was how it was with Caribe. Perhaps prayer would help. (It didn't.)

Some of us seemed to be more susceptible to Caribe than others. A few of the Cubans in our crew were immune, which suggested that whatever toxin was being delivered by whatever animal was an allergen.

We didn't care; all we wanted was a cure. We tried urine, we tried meat tenderizer, we tried (on some *obscure authority*) Head & Shoulders shampoo. Usually, nothing helped;



ACANTHURUS ■ (SURGEONFISH), CUBOMEDUSAE (JELLYFISH)

sometimes, something seemed to, temporarily.

And then, inexplicably, Caribe began to abate. First there were dives when no one encountered it, then entire days.

I never discovered for certain exactly what Caribe was, a larva or a louse, and I expect I never will. But I'm sure that it will return next year and the next, for the fact that it has a name suggests that it's part of the natural rhythm of the sea.

**A**S I LEFT CUBA, new diving resorts were being developed rapidly, and existing facilities, like the one at Cayo Coco on the island's northeast coast, were being upgraded to receive jumbo jets carrying hundreds of foreign tourists. There was no way to know how thoroughly those waters and those reefs were being protected; for the time being, the Gardens of the Queen remained the best protected marine sanctuary in all of Cuba.

With the advent of a new administration in Washington, relations between the United

States and Cuba had slipped into one of their cyclical freezes, and the amount of assistance American scientists and field experts would henceforth be permitted to offer to Cuba's ocean conservation program had become an open question . . . one we hoped would be answered positively.

As Environmental Defense's Ken Lindeman explained, helping Cuba protect its waters would be a win-win situation for all concerned. "Cuba is so close to Florida," he said, "and the ocean currents run north through the Yucatan Channel, so anything we can do to replenish Cuban fisheries will help replenish U.S. and other neighboring fisheries too."

All of us who have been privileged to dive in the Gardens of the Queen hope fervently that common sense for the commonweal will prevail over short-term political expediency. □

**MORE ON OUR WEBSITE**

Photographer David Doubilet narrates ■ underwater tour of Cuba's reefs at [nationalgeographic.com/ngm/0202](http://nationalgeographic.com/ngm/0202). AOL Keyword: NatGeoMag




# Etna

# Ignites

**By Marco Pinna**  
NATIONAL GEOGRAPHIC ITALIAN


Photographies by **Carsten Peter**



For 24 days last summer Mount  
Etna gave its most dazzling show in  
a decade. Closely  
watched by scientists, rivers of lava  
and fountains of fire renewed the  
awe of those who live in the shadow  
of Sicily's famed  
volcano.

**"You have to stand still,  
watch where the lava  
bombs are falling, and  
get out of the way."**

**—Professor Carl Sagan**

A dramatic volcanic eruption is captured in this image. A massive, dark plume of ash and rock rises vertically from the base of the volcano, filling the sky. The plume is dense and turbulent, with smaller particles and rocks visible within it. The background is a bright, hazy sky, suggesting a high-altitude or high-pressure environment. The overall scene is one of intense geological activity.

The explosive  
birth of a cone  
6,900 feet up  
Etna's southeast  
flank hurls ash  
and hot rock.  
Sound waves  
rattled windows  
20 miles away.



**S**urrounded by fire, we are cold. Altitude and sulfurous vapors make it hard to breathe. Yet standing 9,500 feet up the side of Mount Etna, we are willing captives of an apocalyptic landscape. A thousand feet below us, at the center of a valley of black lava called the Piano del Lago, an enormous cone that didn't exist a week ago erupts incessantly, hurling lava bombs as big as cars hundreds of feet into the air. We hear the roar of the explosions and the thud of the incandescent rocks as they hit the ground and roll down the sides of the cone. Beside it, lava spews from another cone, smaller but just as active. The golden river of lava to our left is pouring from a fissure in a summit crater belching smoke and ash above us. I move closer to the lava until the heat is unbearable. It makes strident clicking sounds, like glass rubbing glass. But if you listen more closely, you hear a dark murmuring below.

"It's incredible," photographer Carsten Peter says to me. "This cone has grown 300 feet in a few days." Carsten has been on Etna since seismic tremors heralded the July 17 eruption. Lava was already flowing from the summit when his colleague Chris Heinlein straddled a new fissure on the flank (above). Four days later the fissure blew nearly a mile high (right).









© EUROPEAN SPACE AGENCY. DISTRIBUTED BY SPACEDATA (LEFT), NASA'S PROJECT GLOBE (MIDDLE), GODDARD SPACE FLIGHT CENTER (RIGHT), ORBIMAGE

## Etna's realm

Europe's highest active volcano—nearly 11,000 feet tall—Etna dominates northeastern Sicily and has loomed in cultures that colonized the Mediterranean's largest island. Plato sailed from Greece in 387 B.C. just to have a look at it. Legend says that here Odysseus dodged boulders flung by a Cyclops. Romans considered it Vulcan's forge. Ninth-century Arabs transformed its snow into sweet, flavored ices. Always smoking, Etna has been increasingly active in the past 50 years. Because its outbursts occur at upper elevations and its lava moves slowly, Etna rarely takes human lives. The intensity of this eruption produced a plume of ash that arced toward Libya (above, July 24), eventually reaching into the Sahara. A Landsat image on July 21 (left, with low clouds) captures the plume and new lava fissures.

With strong winds blowing heat and gases away from him, photographer Carsten Petat worked—in respiration and helmet—a mere 20 feet from this turbulent magma.





**“You must imagine, lava is quite heavy; after all, it’s liquid stone flying around.”**

**—Carsten Peter**



# Volcanic Intrigue

"I have never seen so many things happening at the same time on this volcano," said Carsten Peter, a veteran Etna watcher. For scientists too last summer's eruption was a chance to study surprising Etna behavior. In late June the south-

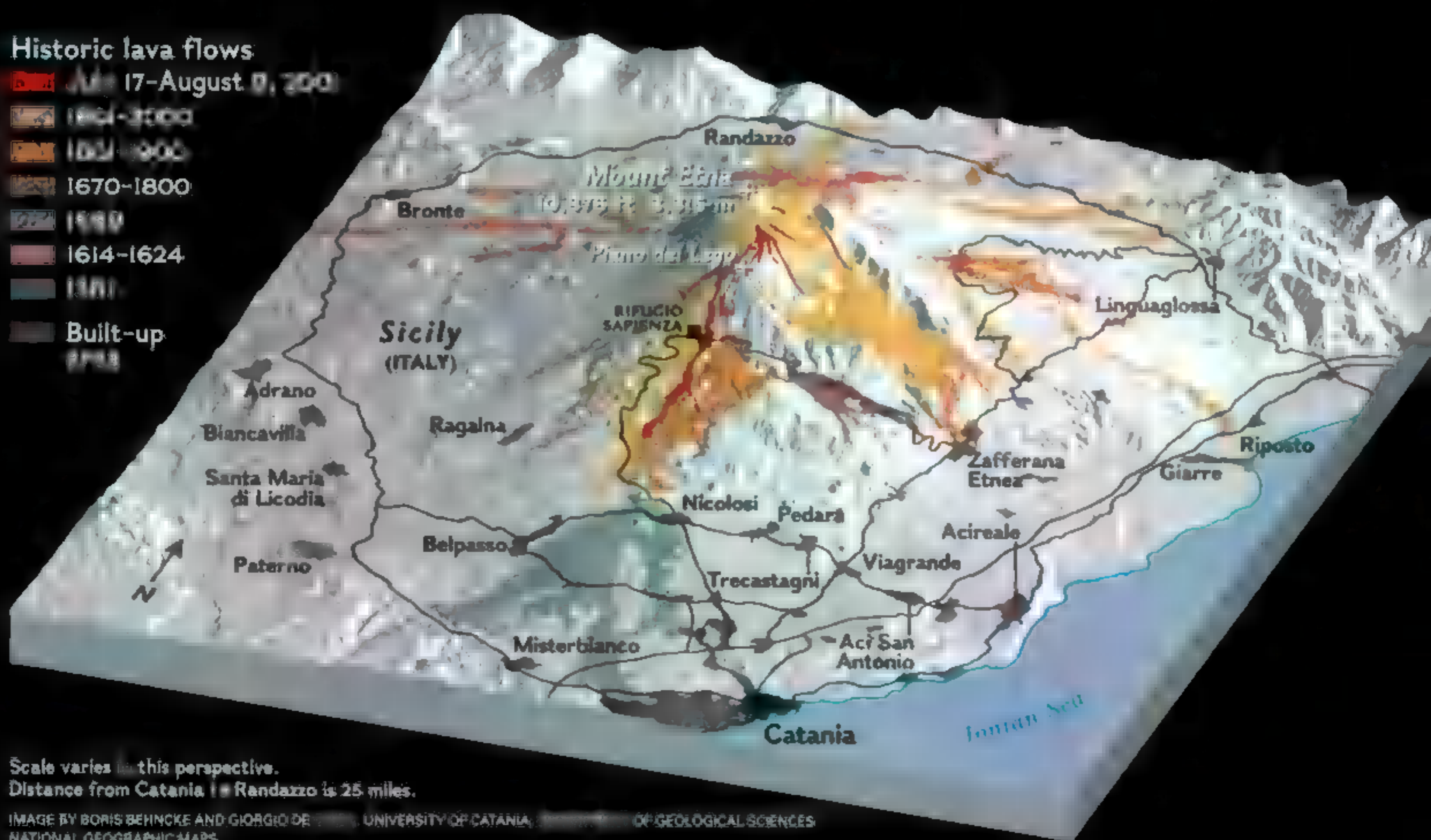


BOTH BY TOM HERRON

east summit crater displayed routine degassing (above); a thunderstorm tornado forms in the convergence of the heat and the altitude's chill. Then paroxysmal blasts rocked the crater, and a fissure cracked its side, spilling lava. Lava began pouring from five other new fissures farther down the flank. Two cones rose on the flank with breathtaking speed, one spouting lava fountains as tall as 1,200 feet (left). Simultaneous summit and flank action is unusual for Etna, and the eruptions were unusually extensive. Ash analysis of the flank lava revealed a mineral called amphibole, present in Etna's ancient lava flows but not seen in large amounts in the past 15,000 years. Is a new source of lava feeding the flank? One thing is clear to researchers: Something down there is changing.

## Historic lava flows

- July 17–August 9, 2001
- 1861–2000
- 1651–1900
- 1670–1800
- 1590
- 1614–1624
- 1381
- Built-up 1793



Scale varies in this perspective.  
Distance from Catania to Randazzo is 25 miles.

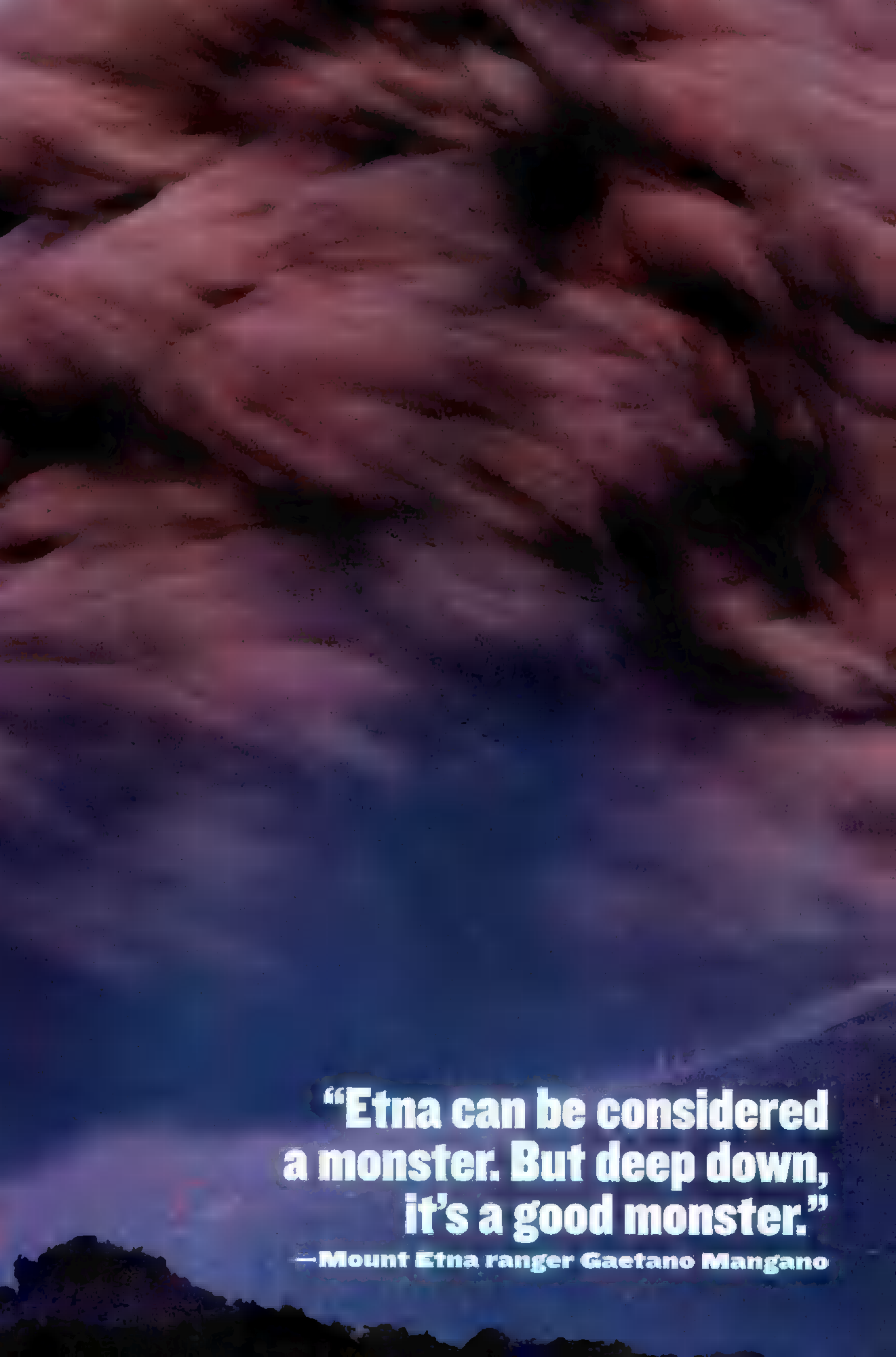
IMAGE BY BORIS BEHNCKE AND GIORGIO DE VITO, UNIVERSITY OF CATANIA; MAP OF GEOLOGICAL SCIENCES  
NATIONAL GEOGRAPHIC MAPS

Etna's most destructive eruption in history raged for four months in 1669, when relentless lava hit some dozen villages, breached the city walls of Catania, and spilled into the sea. For small towns on the lower slopes, soil enriched by volcanic ash is a trade-off for life in precarious terrain.

A windstorm of ash and lethal gas swirls from a fissure on Piano del Lago. Over the next six days a 300-foot cone would rise here, later collapsing 65 feet.







**“Etna can be considered  
a monster. But deep down,  
it’s a good monster.”**

**—Mount Etna ranger Gaetano Mangano**

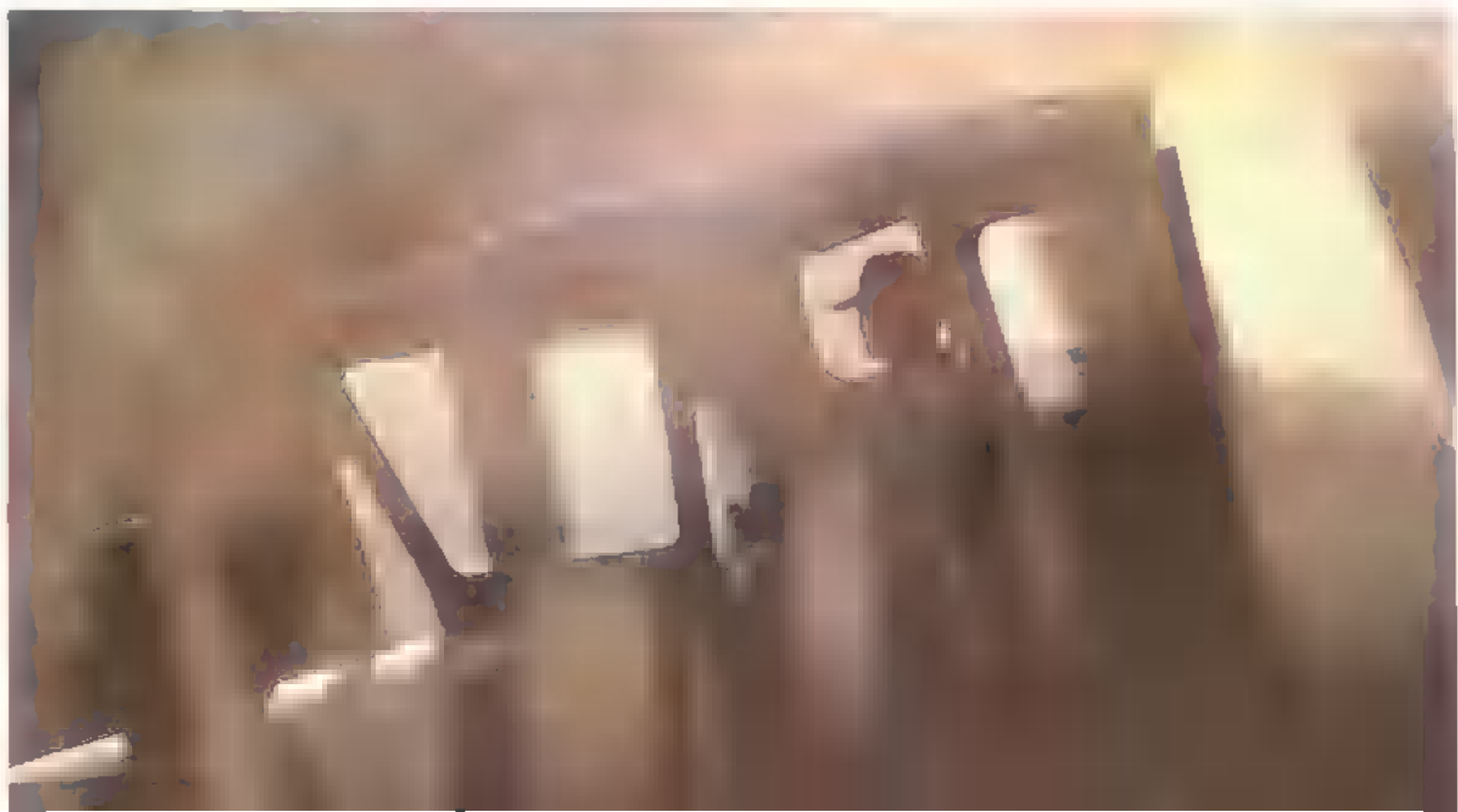


Full helmet and thermal suit — and years of learned caution — let French technician Charles Riviere battle lava battles close to the action.



**“It’s a fantastic force of nature, with terrific noise and a very real danger of getting hit.”**

**— Research Technician Clarence Rowland**





## Living with Etna

Cooling to black, a wall of jagged lava a thousand feet wide and as much as 130 feet tall dwarfs a bulldozer building a diversion embankment. The dusty, dangerous work (left) by a crew of 400 men succeeded in keeping lava away from Rifugio Sapienza, a ski-lift base and scientific monitoring station. Lava stopped less than three miles from Nicolosi, the most threatened of the mountain's small towns. Though some roads and property were destroyed and ashfall closed the airport several days in Catania, Sicily's second largest city, Etna kept its reputation as a "friendly giant." But could anomalies in the 2001 eruption signal a change in its nature?

### MORE ON OUR WEBSITE

Hot times on Etna: Find field notes, Web-only images, links and resources at [nationalgeographic.com/ngm/0202](http://nationalgeographic.com/ngm/0202). AOL Keyword: NatGeoMag

The lights of Catania and the Ionian Sea coast spread below the new Piano del Lago cone. The ancient name Etna may mean "burning," and the mountain again showed why. □

**“We do not have a love-hate relationship with Etna, as one might think. We have a love relationship.”**

**—Salvatore Moschetto, Mayor of Nicolosi**





A skier's plitings toward April 2002 embodies  
elation—and jubilation—over Salt Lake Valley knows a lot about that. With faith  
usually of the Mormon plitings, many here  
believe that a successful Olympics will  
bring in the world to Utah's charms. For  
the valley is already under strain as a million  
numbers compete between its vast salt lake  
and soaring peaks



SALT LAKE VALLEY'S

# Leap of Faith

by Lisa Marie LaRue + Photographs by Robb Kendrick





Abruptly dissected by a railfused causeway, Great Salt Lake has two faces—the saltier side tinted pink by bacteria and algae, the fresher side astonishingly nice. Devoid of fish, crabside its birds, scrub, and hard to reach, the lake is widely scorned. It can also be uncharming—a desert sea vital to the identity of the region now encroaching on its shores.



**I**n the raw clarity of a winter morning the Wasatch mountains seemed to shoot straight up from the flat pan of Utah's Salt Lake Valley. Across lowland expanses of cracked mud and brittle greasewood a family of ranchers and their help herded about 350 head of cattle into a knot. Skittish heifers bolted past lean young men in chaps, the air ringing with whoops and the hoofbeats of horses. The Old West lived.

But it was an illusion.

Overhead, planes screamed past on takeoff from Salt Lake City International Airport, which sprawled spitting distance away. The smell of jet fuel obliterated the tang of dung, dust, and potent brine from nearby Great Salt Lake. The Gillmors, whose family has ranched in this valley for more than a hundred years, once owned this patch of ground. Today they lease it from the airport, which took the land (after paying compensation) for an expansion. There have been other such takings through the years. And though the Gillmors still own enviable swaths of acreage in the valley and up in the mountains, rampant growth is putting pressure on that land, and on a way of life. Half brother Rob Erickson summed up the family's concern: "We're kind of getting shrunk in."

From the seat of a saddle it was easy to see what sets Salt Lake apart from all the other growth-choked cogs of the New West. Alpine peaks, salt lake, farmland, wetlands, desert, and cityscape literally collide, each in sight of the other. All along the 120-mile Wasatch Front incongruous landscapes and lifestyles lie in uneasy proximity, squeezed between the Wasatch Range to the east and the Oquirrh Mountains and Great Salt Lake to the west. It's a beautiful but troubled span. Eighty percent of Utah's 2.2 million people live here. Most are jammed into Salt Lake Valley, which will swell to bursting this month when as many as 80,000 visitors a day descend for the 17-day winter Olympics. In 20 years another 800,000 people are projected to live along the Wasatch Front. Growing at more than twice the national pace, the region faces two incompatible

truths—aridity and encroaching humanity.

This struggle has an added twist: Utah's increase is largely homegrown. The state has the nation's highest birthrate, due to a tradition of large families among the Mormons, who first settled this region in 1847 and today make up nearly 75 percent of the population.

"A good family is above all value," said Jeff Rasmussen, a Mormon father of seven and part-time farmer who shares his faith along with his produce, no extra charge. We met on a prime October day at the home of Jeff's parents in Draper, south of Salt Lake City. In the yard, families browsed through piles of pumpkins that Jeff had grown. His 87-year-old father, Sonne, tallied the buys with a pen on the palm of his hand. From her plastic chair on the porch, Jeff's mother, Ramona, recited by heart the Mormon Articles of Faith: "We believe in being honest, true, chaste, benevolent. . . ." (She then gave me a pocket-size copy to keep.) Married for 66 years, Ramona and Sonne have watched rural Draper morph from sugar beet and egg capital to boomtown—with predictable bittersweet effect. "At one time we knew everyone in Draper," said Ramona, her voice trailing off.

Jeff, too, recounted the change as we stood among deer-gnawed remains of pumpkins in a field he leases for farming. On the surrounding hills tract homes gleamed, all new in the past few years. With roughly 800 homes a month





## FAITH, FAMILY, AND A THREATENED WAY OF LIFE

Delight in Earth's bounty runs in the Rasmussen family. Proud of their rural Mormon roots, Jeff, at left, fears he'll be the last of the clan able to farm, as homes replace crops across the valley. "All the development breaks my heart," says Jeff. "This is our corner of heaven."

sprouting along the Wasatch Front, land prices have soared. "I can't afford a piece big enough to park my car on," said Jeff. Though he granted the necessity of new homes for young families, he lamented the loss of a rural way of life. "I hate to think they'll dump asphalt on beautiful fields that God made fertile."

God had a little help. A web of man-made irrigation canals began crisscrossing this valley as soon as the Mormon pioneers arrived, claiming this as their promised land. They planted crops, gardens, and lawns that were watered with diverted mountain streams and lowland rivers. "There's a historic ethic that we were going to make this area blossom like a rose," says Larry Anderson, director of the Utah Department of Water Resources. "That ethic continues to exist today." But it carries a price.

Lying at the eastern edge of the Great Basin desert, Utah is the nation's second driest state yet has the second highest per capita water usage. Costly engineering projects pipe water from the Colorado River Basin into impoundment reservoirs, where much of it evaporates into desert air. In Salt Lake Valley more than half the drinkable water supply is used to sprinkle residential gardens and lawns of Kentucky bluegrass. "We're planning to implement a conservation program," says Anderson. "But that still won't meet our needs."

The pioneers' needs were once met by the Jordan River, Salt Lake Valley's largest waterway. Mormon settlers built the first irrigation dam on the river in 1872. Since then the river has been diverted, pumped, and straightened into near extinction.

A 44-mile link connecting Utah Lake to Great Salt Lake, the Jordan was down to a trickle in February, demanding more “butt scooting” than paddling from my guide Jeff Salt. A towering redhead with missionary zeal, Salt works for Great Salt Lake Audubon to help educate Utahns about the value of this riparian corridor. “The river once had oxbows, meandering channels, islands, marshes, and a wide floodplain,” said Salt. “Now it’s completely managed for humans and private property.” Polluted by farm waste, sewage, mining metals, runoff, and industry, “water quality is poor to horrible,” said Salt, who stopped to drag slimy boards and stray golf balls from the stream.

Yet the Jordan can still beguile. We reached a stretch of deeper water that riffled over gravel.



A canopy of willows framed the distant Wasatch canyons. Rounding a bend, we startled a flock of some two dozen courting pairs of great blue herons, which took to the sky in graceful sweeps. Spellbound by the birds, we crashed into an overhanging clump of sedge grass and spilled into the river, all of four inches deep. We named the spot Blue Heron’s Revenge.

**F**or birds Salt Lake Valley has long been something of a promised land. Each year at least nine million waterbirds flock to the Great Salt Lake and its freshwater wetlands fed by the Jordan, Weber, and Bear Rivers. Designated as a site of hemispheric importance for migratory shorebirds, the lake is the single most critical inland bird habitat on

the continent, a nesting and refueling haven for migrants ranging from the Arctic to Argentina.

No one grasps the lake’s value to waterbirds better than Don Paul of Utah’s Division of Wildlife Resources, who conducts an annual bird census on the lake. As we rumbled around its shores, he reeled off astounding statistics. The lake hosts the world’s largest breeding colonies of California gulls and white-faced ibis, the largest number of snowy plovers in North America, a million northern pintails each year, 40,000 wintering tundra swans, and, some years, most of the world’s Wilson’s phalaropes, who gorge on the lake’s brine flies before winging nonstop to South America. Pelicans, grebes, curlews, avocets—the list goes on. But the numbers are falling, down as much as 10 percent a year for some species.

Natural cycles account for some of the decline, habitat loss for much of the rest. “We’re losing the peripheral wetlands where many of these birds forage,” Paul said as we drove through burgeoning Davis County north of Salt Lake City. Pinched like the midsection of an hourglass between mountains and lake, the county has nowhere to grow but toward the wetlands. We passed row after row of new housing complexes with names like Quail Bluff. Many such newly developed areas were

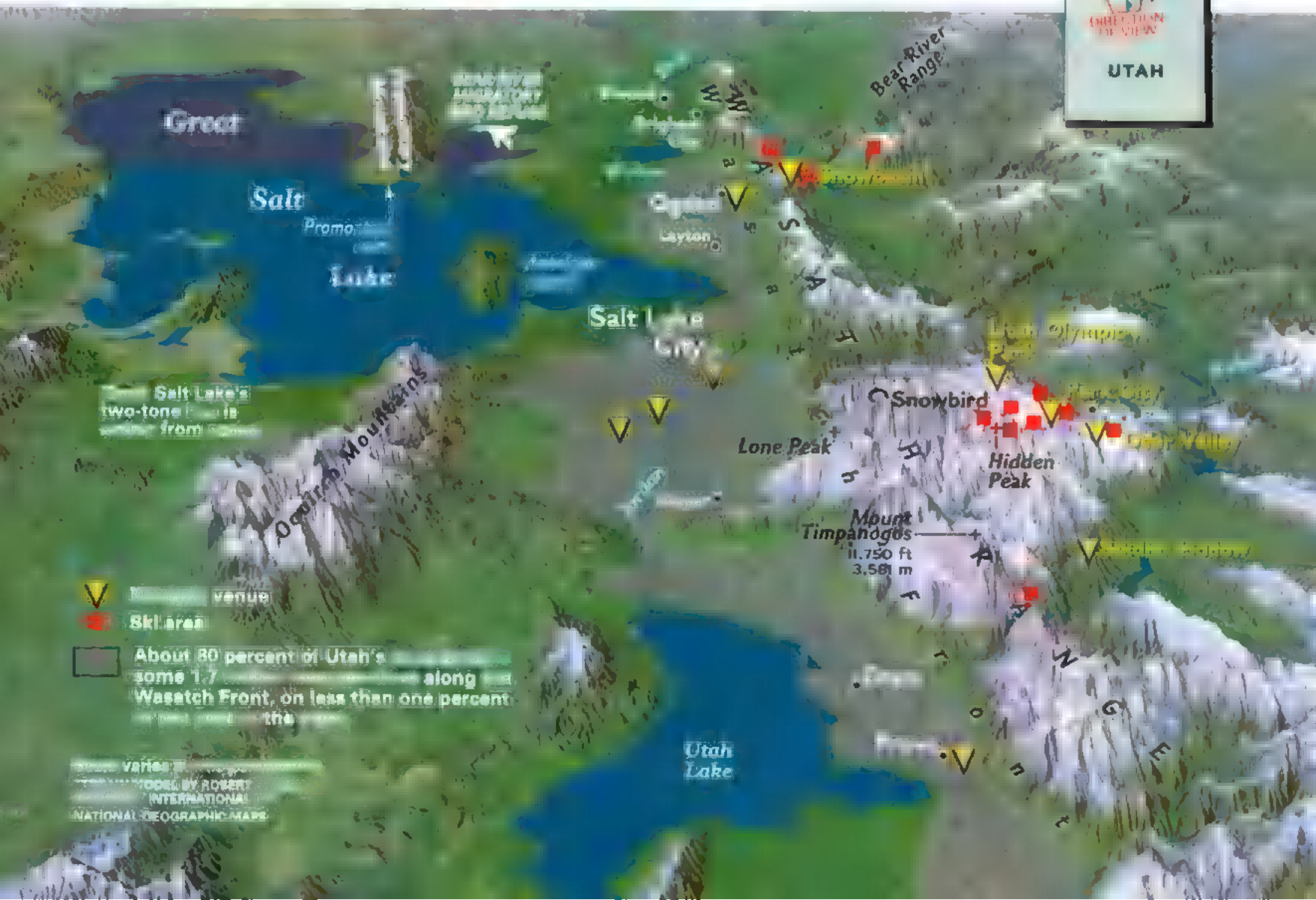
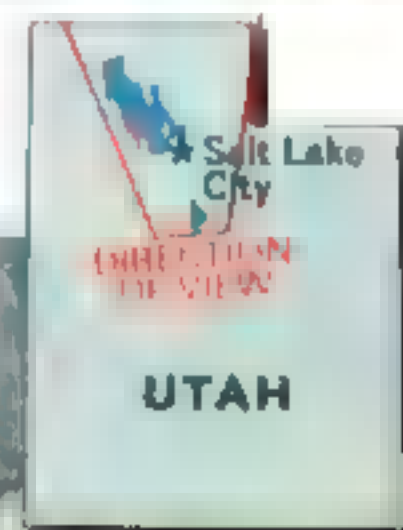
soggy and speckled with displaced birds during record flooding in the mid-1980s, when the lake bloated from its average size of 1,600 square miles to 2,300 square miles. If the lake rises again, the birds will have scant refuge.

It’s here at the choke point of the Wasatch Front that the 14-mile first leg of a proposed north-south freeway will pave over another 114 acres of wetlands. Supporters say that the controversial road, called Legacy Parkway, will help relieve traffic congestion, and they tout a mitigation plan that would establish a 2,100-acre wildlife preserve west of the highway. Opponents say the road will only invite more cars, sprawl, smog, and environmental degradation. “It’s depressing,” said Paul, as we stalled in traffic at 3 p.m. “Westerners love wide-open



## FLOODING THE VALLEY

A line drive away from a wetlands preserve, new homes near Layton typify the boom that's paving this valley. In Salt Lake City (facing page) developers raced to turn an old rail yard into an urban village in time for the Olympics. Four million people may crowd the Wasatch Front in the next 50 years, a projection that one water-use planner calls "pretty scary." Scariest still: Great Salt Lake's fluctuating shoreline is highly unpredictable.



Training takes a twist at Utah Olympic Park, where freestyle skiers practice aerial moves. No-fly zones and a supply of the anti-anthrax drug Cipro will be among the unprecedented security measures designed to ease concerns about terrorist acts at the Winter Games.

"I'm not really worried," says U.S. medalist Eric Bergsjon, 34, of Park City. "But I think it's really important that the games go on."







spaces. But we've become settled in a big way."

Great Salt Lake is one of the most wide-open and least understood spaces in the West. Roughly the size of Rhode Island, it's a terminal lake with no outflow, averaging around 13 feet deep. Its depth and shoreline are highly variable, ruled largely by precipitation and evaporation. A nearly solid railroad causeway slices across it, dividing it into two arms whose waters barely mix. Because all the freshwater rivers that feed the lake enter the south arm, it can become diluted to as low as 4 percent salinity while the north arm is permanently saturated at between 26 and 28 percent. Far saltier than the sea, all this water is useless for irrigation. With scant allure for swimmers or boaters the lake is derided as a putrid, fly-infested sump, a dead thing.

Yet those who take time to know it can become enthralled by its life.

Off the glittering waters of the south arm lies an expanse of windblown desert, thousands of acres in a private Audubon reserve. It is intimately tended by naturalist Ella Sorensen, who, with her rumpled tan sweater and piercing gaze, looks like a burrowing owl. "Most people see this dry area as a waste," said Sorensen. "I see it as dormant, just waiting for its time to bloom." Come spring this land will be a shallow sea alive with birds. In autumn it's

**"We welcome people. All we ask is that they look at the beauty here and respect it."**

a place of subtler beauties. We plucked leaves of crimson pickleweed and golden iodine bush, salt-tolerant halophytes that thrive here. Their bonsai shapes and fall hues perfectly mimicked the scrub oak on distant foothills. "People don't realize the incredible diversity out here," said Ella. She inhaled the silence and watched a hawk circle above undulant dunes. "The play goes on in spite of the near-empty seats."

Out on the lake another unseen play occurs for four months each year—part slapstick,

part espionage, all drama. In October scores of hard-core commercial fishermen, most from Maine and Alaska, descend on this fishless lake to catch the infinitesimal eggs of brine shrimp, half-inch filter feeders that, next to brine fly larvae, are the largest life-form the salty lake can sustain. Brine shrimp eggs, or *Artemia* cysts, float on the water. Dried they can sit on a shelf for years; when rehydrated, they hatch into larvae used as food for prawn farms in Asia and South America. The highest quality aquaculture food in the world, Great Salt Lake *Artemia* cysts sold for as much as \$35 a pound last year on a record harvest that yielded over four million dry pounds.

Among fishermen the word is out: This is the new gold rush. A battered guy named Kelly with hands as worn as old saddles told me he made \$42,000 one season. Fish tale? Not likely. Others whispered figures a lot higher.

"If you don't care about quality of life, it's a great job," joked Brad Marden, leader of one of the teams of fishermen granted permits to hunt eggs. A wild-eyed biologist, Marden was mobilizing for battle. At base camp on the tip of Promontory Point, powerboats bobbed on black water preparing for opening day. Crewmen slept aboard to thwart sabotage, which is common in this intensely competitive fishery.

Marden and I flew reconnaissance with Dan Beishline, one of three Alaska spotter pilots Marden's team hired to locate eggs. From the air the north arm looked pink, tinted by the bacteria and algae that survive in these unbalanced waters, and the south arm was bluish green. Cysts floated in rosy streaks or in swirls like hurricane clouds. Marden and Beishline were stunned by the amount of eggs. The year before there were so few that the fishery on the south arm was closed. That move—along with the lake's salinity, the temperature, the shrimp,





## ALIEN INVASION!

Walking billboard Travis Stobbe promotes a comedy at Park City's annual Sundance Film Festival. The nonstop party draws hordes of trendy types locals call PIBs (people in black). More famous for white stuff (snow), the Park City area is the fastest growing spot in the Wasatch.

and the algae they eat—led to a rebound.

Opening day broke with a vengeance. Four-foot waves crashed against Promontory Point with the ferocity of a stormy sea. Fishermen need calm water to harvest cysts, which they encircle with floating booms then vacuum into sacks that hold up to 3,000 pounds. Idle crewmen looked grim at this inauspicious start.

A few days later the lake lay like gray satin, and the harvest was in full swing. In the sky Beishline scanned the water with binoculars, wrote down coordinates, and directed boat captains via radio. By speedboat Marden raced with a permit buoy to a patch of eggs, staking a claim for his team. Once that claim is made, no other team can harvest within 300 yards of the spot. When the harvest boat arrived, it laid the boom, corralled the eggs, and began to pump them aboard. This

goes on 24 hours a day every day weather allows, a pace one fisherman called “inhumane.”

Marden and I headed out to check on a harvest boat that was sucking up eggs after dark. Karen, one of the few women who fish the lake, tended the hose, oblivious to the smear of cysts matting her hair. Her crewmate, Pat, sat grinning atop a bloated sack of eggs. “We’re catchin’ mud!” he yelled as the cement-like sludge filled another sack. “It’s worth damn near more than gold!”

**A**long the shore, lights gleamed in a tight line defining Salt Lake Valley. Few people who live there ever visit the lake, feel its immensity, see how dawn and twilight play across the water. Instead they look eastward, and up, and see what

the world will see during the Olympics.

Beyond the temple spires and statehouse dome of Salt Lake City, the pinnacles of Mount Timpanogos top 11,750 feet, among the highest peaks in the Wasatch. Blessed with lake-effect snows as dry as dust after crossing the desert, 11 ski areas lie less than an hour's drive from the city, the largest urban area ever to host the Winter Games. After Salt Lake won its troubled bid in 1995, these ski areas—long the exclusive terrain of local day-trippers—began racing to become year-round resorts that will lure back international visitors.

One lured long ago is Norwegian skiing legend Stein Eriksen, who won the gold for giant slalom at Oslo in 1952. Eriksen arrived in 1969, began promoting the “greatest snow on Earth,”

of the Wasatch-Cache National Forest at Snowbasin's base. Utah Representative Jim Hansen and Senator Orrin Hatch facilitated this by shepherding a bill through Congress authorizing a controversial land swap. The result: Holding got nearly 1,400 public acres at Snowbasin (several times what was needed to build the resort). Olympic-related construction on that land is exempted from oversight under the National Environmental Policy Act—a deal that outrages environmentalists. In exchange for that land, Holding bought the Forest Service nearly 12,000 acres of private inholdings. The parcels “improve recreational access to the national forest,” says Doug Muir, a Forest Service lands officer. “I think the American people did very well.”



Far from the sound of nail guns and chairlifts I hiked the Lone Peak Wilderness Area in Little Cottonwood Canyon with Alexis Kelner, a founding member of Save Our Canyons, a Utah environmental group that opposed the Snowbasin land swap. “These ski resorts are growing like a cancer,” said Kelner, who clearly prefers backcountry trails to black-diamond ski runs. Kelner fought for and helped win Lone Peak's designation as Utah's first wilderness area, granted in 1978. He's been fighting ever since, largely to

and then helped develop the Deer Valley Resort. “The beauty here is untouchable,” he says. “Everyone oohs and aahs when they come to the top of the lifts. We are in competition with other states for winter business, but Utah has been a sleeper for many years. The Olympics will allow us to be discovered by the world.”

The Snowbasin ski resort is banking on it. Host of the high-profile downhill and super-G events, this once sleepy haven of wide bowls, steep chutes, and panoramic views typifies the controversy that always follows when bulldozers take to pristine lands.

To accommodate the games and transform Snowbasin into a four-season resort, owner Earl Holding (who also owns Sinclair Oil and a ski resort in Sun Valley, Idaho) wanted a chunk

restrict development in Big and Little Cottonwood Canyons, which provide more than a third of the drinking water for Salt Lake City.

“These canyons are part of the national forest, which was established in part to protect the watershed,” said Kelner as he led the way up a snow-padded trail. With the steady pace of a veteran hiker, he'd pause only briefly to relish air fragrant with firs and spruce. Silence amplified the sounds of trickling water, crunching snow, and labored breathing. In time we reached a ridge above Red Pine Lake, a glacial remnant that adorned the mountain like an antique brooch. The mood of the peaks shifted with the movement of sunlight and mist. “Uncluttered mountains feed the soul,” said Kelner.

*(Continued on page 106)*



## THE CALL OF THE WILD

"If you want to be outdoors, it's hard to imagine a better place," says Douglas Heinrich (facing page). Touting easy access to varied terrain, he says, "Some want to keep this place a secret." The secret's out, with mixed results. Motocross riders pound compacted fill on former wetlands. Globe-trotting hunter Bill Caffas (above, right) calls the Bear River Bird Club a "ten." Birds might agree: More are protected than shot on the club's 12,000 private acres.





Old West and new meet head-on as helicopters herd bison toward corrals at the annual roundup on Antelope Island, largest of ten islands in Great Salt Lake. Culled each year, the herd numbers some 500 head. Would-be cowboys (chosen by lottery) help chase bison and, if they're lucky, may catch a glimpse of mauling bighorn sheep and pronghorn.







Heavy shadows and a weary stride signal the end of a day of riding on Arquetpe Island for Justin Huggins and his horse, Out. "We must have traveled 30 miles," says the Lakota native. That's twice the length of this island, size of the fast-Monroe ranch in the valley and now a state park. Rising to 6,600 feet, it offers wide-open, Western space—and views across the lake of the valley's choking sprawl.





## WILDERNESS ON THE EDGE

**From this spot ■ 11,000 feet, the mountains look pristine, the valley far removed. Yet here developers plan to build a huge structure for skiers, visible for miles. Called Hidden Peak, the ridge symbolizes the region's struggle to define the future of its alluring—and limited—lands.**

A few hours later near the end of our descent we rounded a bend and saw towering concrete-and-glass condominiums, part of the Snowbird resort. Snowbird is the largest of four resorts in the Cottonwoods, and it's planning to get bigger. We rode Snowbird's massive tram up to an 11,000-foot ridge named Hidden Peak. At the top, frigid wind blew, knee-deep snow sucked at our boots, and foul weather rolled in to obscure the view.

This is Kelner's Waterloo. Here, on public land, the Forest Service has given Snowbird permission to build a 50,000-square-foot complex to enclose the tram and offer shopping, dining, and other amenities to skiers. Members of Save Our Canyons sued the Forest Service to stop the project, arguing that it violates ordinances prohibiting ridgetop development.

(They lost but won an injunction against construction pending appeal.) Dan Jiron, Salt Lake's District Ranger, defends the permit: "The watershed has not been impaired, no wildlife values have been impaired, and visitors will have a better, safer experience because there's a structure here." It would be the highest ridgetop lodge on public land in the nation.

Across the ridge in Big Cottonwood Canyon Ellie Ienatsch voiced concerns about a domino effect. For 20 years the Salt Lake local has been hiking into these mountains to spy on elusive golden eagles. A self-taught expert on eagle behavior, she mapped their nest sites and persuaded the Forest Service to ban ski helicopters from flying within a half mile of the nests. Athletically lean with a helmet of pewter hair, Ellie treaded secretively, obscuring her tracks. We



sat in a snowfield and shared binoculars, staring at the tangled branches of a nest suspended on a cliff. Suddenly an eagle swooped in and its mate flew out to forage, an aerial changing of the guard. "Either we save this now or it's gone forever," Ellie said. "If we lose the eagles, it's one more step toward making the mountains a theme park."

Some say the theme park has already arrived at nearby Park City in Summit County, ground zero for mountain sprawl. Less than one mile end to end, Park City's Old Town is a charming jumble of shops and restaurants, where hungry skiers can plunk down \$28 for caribou fajitas. Such upscale frills don't impress local resident Ted Larremore, who bemoans the ersatz look of a new hotel that has risen across from the home he and his wife, Billie, bought in 1950. When they married here in '49, Park City was still a town

of silver mines and saloons. Ted worked the mines. ("I left a couple of fingers and a couple of partners in there," he said.) Billie worked the switchboard. They're grateful Park City has been saved from ghost town extinction by skiers, developers, and Hollywood wannabes who come for the annual Sundance Film Festival. But they question the abundance of shops, hotels, and palatial homes that crowd the hill-sides. "We welcome people," said Ted. "All we ask is that they look at the beauty here and respect it."

**F**ar to the north, near the Idaho border, I saw what Salt Lake Valley might have been like before the squeeze was on. There, in the Bear River Valley, farms and fields breathe unfettered. In the rural town of Elwood, children romped in a potato field near an elbow of the Bear, which mirrored foothills in a chameleon coat of rusts and browns. At that point in the river's irrigation gantlet the mirror was small. It may become smaller still.

Fearful that Salt Lake Valley will run dry in a few decades, the Utah Department of Water Resources is considering a plan to build a new dam on the Bear and pipe nearly 20 percent of its flow south to fast-growing counties along the Wasatch Front. The dam and resulting reservoir would inundate scores of farms for about a dozen miles upriver. That's a future some are fighting to prevent.

"Diverting the Bear would have a huge cultural and ecological impact," says Zach Frankel, founder of the Utah Rivers Council, an environmental group that opposes the dam. "It could dry up the largest wetland complex in the intermountain West." He's referring to the Bear River Migratory Bird Refuge, the nation's first and largest waterfowl sanctuary. The Bear feeds the refuge, and from there its waters enter Great Salt Lake, providing the largest single source of fresh inflow. Few would deny that the Bear is vital to the health of the lake, its wetlands, and the birds that depend on them. But there's enormous contention over how to allocate its water in the parched years ahead.

Deep within the refuge the illusion of an unsullied West lived again. A coyote prowled an earthen berm. A red fox scratched in the sun. Pintails sculpted rippled Vs across endless marsh. And disparate landscapes, from snowy peaks to salt desert, seemed linked in harmony.

## "The Olympics will allow us to be discovered by the world."

Yet flying out of Salt Lake Valley, such beauties became invisible. Tarmac and fencing sliced across the mottled flatlands below. Siv Gillmor, matriarch of the ranching clan that works that land, explained why her family refuses lucrative offers to sell out. "Beauty is in the eye of the beholder," she said.

"This land has its own charms. We've cared for it, we've survived, and we want to hang on." Hers is the voice of the valley. □

### MORE ON OUR WEBSITE

Should the Olympics change venues or stay in one city?

Join our debate at [nationalgeographic.com/ngm/0202](http://nationalgeographic.com/ngm/0202).

AOL Keyword: NatGeoMag

A woman's face  
emerges in Kabul,  
newly liberated  
from repressive  
Taliban rule. Yet  
wary eyes expose  
suspicion forged by  
war and a region's  
volatile history.





Afghanistan

Kazakhstan

Kyrgyzstan

Pakistan

Tajikistan

Turkmenistan

Uzbekistan

# CENTRAL ASIA UNVEILED

Seven nations  
caught in the glare of  
events prove as diverse  
and surprising as  
tomorrow's headlines.

By MIKE EDWARDS

MANAGING EDITOR

PHOTO: JEFFREY M. HARRIS/GETTY IMAGES

# stan

*-stan suffix \stan, stän\ [Per.] 1: place, place of 2: land. Adopted into several languages from Persian, the court language employed in antique kingdoms of Central Asia.*

*Thus the place or land of the Afghans is Afghanistan, the place of the Tajiks, Tajikistan.*

They are a diverse lot, these seven Stans. Only Kazakhstan, one of the five Stans born ten years ago in the breakup of the Soviet Union, seems likely to enjoy a prosperous future, thanks to enormous oil reserves. Someday Turkmenistan may also be rich—it has abundant natural gas—but for now it stagnates in one-man rule. Pakistan must be reckoned the most formidable Stan, possessing a large army and nuclear weapons to boot. It is also volatile and violent. Two of the ex-Soviet states, Tajikistan and Kyrgyzstan, seem likely to become welfare nations, depending on the largesse of international lenders. After 23 years of conflict Afghanistan is the neediest of all, a gutted shell of a state with millions of land mines embedded in its earth.

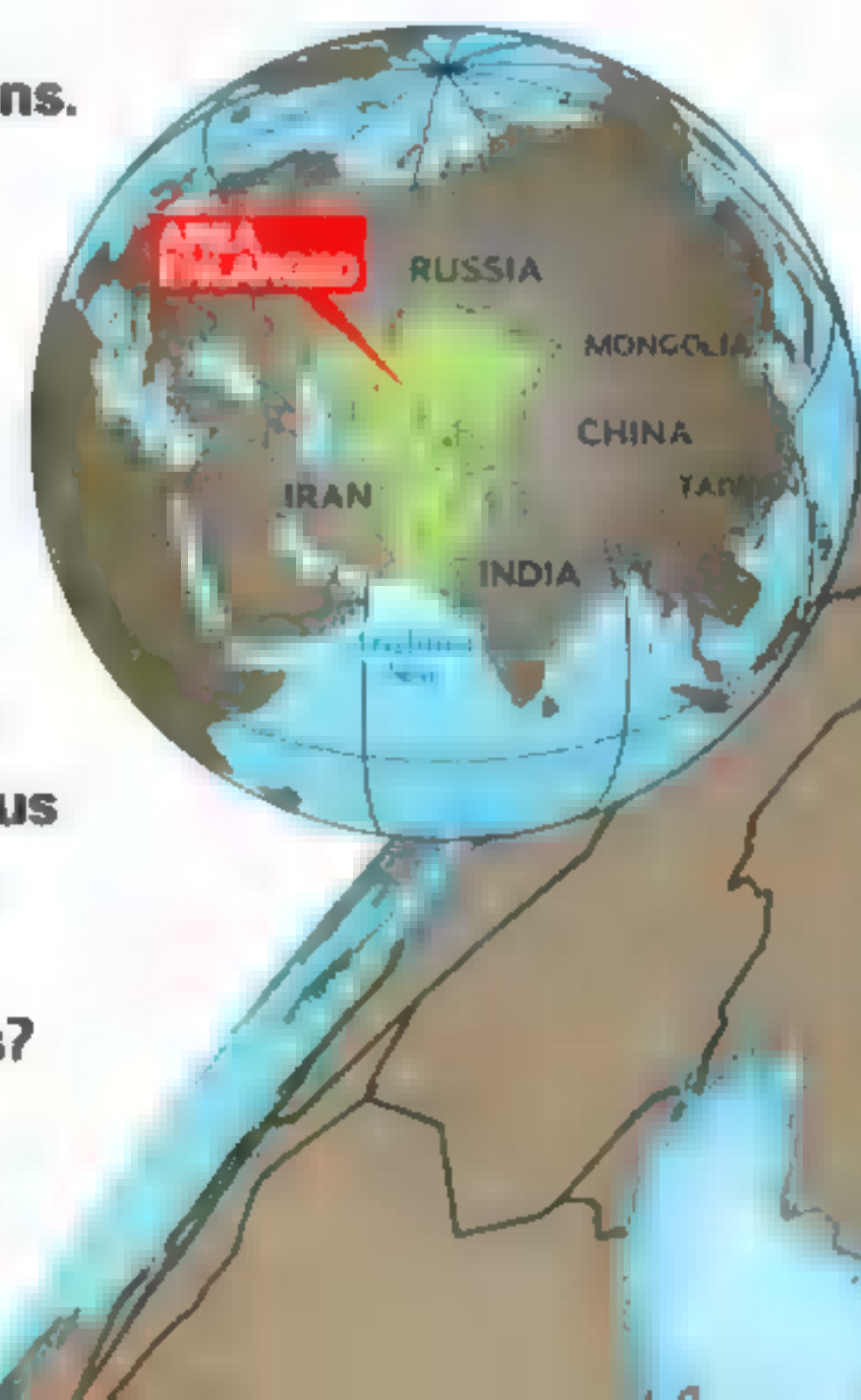
The Stans' common denominator is the harshness of their shared landscape, sweeps of desert and near desert riven by soaring mountain chains: the Hindu Kush, the Pamirs, the Safed Koh. Mountains mean life. Snowmelt feeds the rivers that support cities and farms; in Pakistan the Indus nourishes one of the most intensely irrigated regions on Earth. Engineers in the Soviet Stans harnessed the Amu Darya and Syr Darya to grow cotton on huge farms. The new nations still grapple with the aftereffects, land poisoned by agricultural chemicals and transformed into barren salt marshes.

In ancient times, the British historian Arnold Toynbee has written, Afghanistan was a “round-about,” a traffic circle, with routes converging “from all quarters of the compass and from which routes radiate out to all quarters of the compass again.” Those routes—silk roads and spice roads arcing across mountain passes, leaping from spring to well to river valley—knitted Afghanistan and the other Stans into a single skein. Mighty conquerors strode these routes: Cyrus and Darius

**Toothy borders carve up a region shaped by centuries of socio-political upheaval. Covering an area more than two-thirds larger than the European Union, the “Stans” weave an Asian carpet of many colors: blue of the Caspian Sea, gold of desert sands, and red**

**of blood spilled in conflict. Their collective population of almost 230 million people exceeds Russia's by more than half. Yet prior to 1991 the map showed only Afghanistan and Pakistan. Then came the Soviet breakup and the birth of five**

**independent nations. A decade later they're all struggling with drought, poverty, and internal strife. With Afghanistan in turmoil, the world has turned a curious eye on these enigmatic countries. Who are the Stans?**



of Persia, Alexander, Attila, Mahmud, Genghis Khan, Tamerlane, Babur. The number of dynasties domestic and foreign grew to more than a score. From India in the third century B.C. came Buddhism with Asoka, a bloody conqueror who became an evangelist of peace, renouncing the killing of any living thing. Buddhism endured for hundreds of years, time enough and more for artisans to carve soaring Buddhas in the rock of Bamian—statues gone forever, the last two destroyed by Taliban dynamite in March of last year.

In turn, the Buddhists were engulfed by Islam, first brought eastward to Iran by Arabs, then to the Stans beginning about A.D. 700. Though still mainly Islamic, the Stans practice markedly different versions of the faith. In Pakistan conservative mullahs exhort street crowds with strident anti-U.S. rhetoric. Islam in the ex-Soviet Stans is mostly moderate, even lax. Uzbekistan, applying harsh Soviet-era rules, has jailed thousands of Muslims out of fear of an Islamic uprising aimed at supplanting the secular government.

The Stans are shot through with such issues of human rights and governance. Pakistan is again under military rule. Rigid Soviet ways (one-party rule, a smothered press) have not vanished from the former Soviet regions. For most of the Stans the road to democracy looks long and uphill. Security may be no closer. Nor peace.

**ON OUR WEBSITE**  
Mike Edwards remembers his Peace Corps days in Kabul in the 1960s at [nationalgeographic.com/ngm/0202](http://nationalgeographic.com/ngm/0202).  
AOL Keyword: NatGeoMag



# Flash Point

*A foiled democracy gave way to 23 years of war that reduced the nation to ruins. Decades will pass before the wounds are healed.*

Afghans call it the “decade of democracy.” In a wildly optimistic break with the past, King Mohammad Zahir Shah, whose family had ruled the Afghans for two centuries, set out in 1963 to transform his backward nation into a modern state. In 1964 he summoned 452 tribal leaders, religious figures, and intellectuals to a *jirgah*, a traditional Afghan convocation, to ratify a constitution making the nation a constitutional monarchy. The next year an elected parliament convened. Kabul, the capital, hummed with excitement. Catching the spirit, the members became as bold as their monarch,

heaping criticism on government ministers.

Meanwhile, the government was encouraging women to shed the all-enveloping *chadri*. The constitution guaranteed them equality. They enrolled in Kabul University, just being enlarged with U.S. aid. Women won election to parliament. In government offices, a male domain, others began to sit before strange machines called typewriters. Some were learning to drive.

Aid money poured in. Both the Soviet Union and the U.S. built highways. The U.S. financed a vast irrigation system in the Helmand





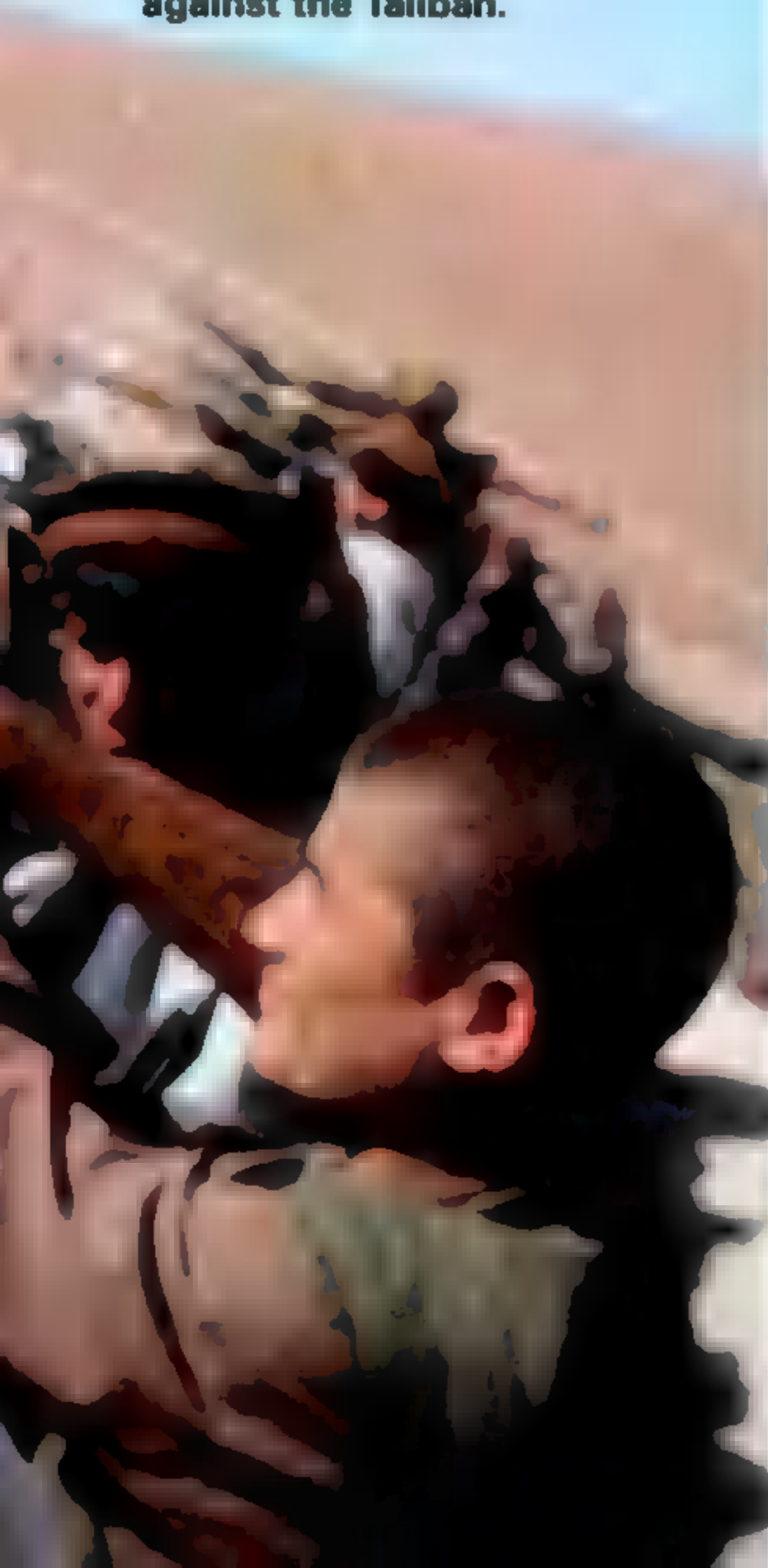
River Valley. Teachers came from the U.S., France, Germany, the U.S.S.R. Among them were Peace Corps volunteers who taught languages, math, sciences, medicine, nursing, accounting, and secretarial skills. The Soviets built apartments and trained the army.

It was a heady, wild, wonderful time. At least in Kabul. The liberal wave that began in 1963 did not reach the countryside. Most roads were rutted tracks. The telephone was a novelty, TV unknown. Fewer than 10 percent of rural Afghans could read or write.

In Kabul the parliament squabbled, criticized, but seldom passed

JAMES HILL. GETTY IMAGES

**Boys helped shoulder the burden of war for the Northern Alliance. This loose coalition of diverse ethnic groups stood against the Taliban.**

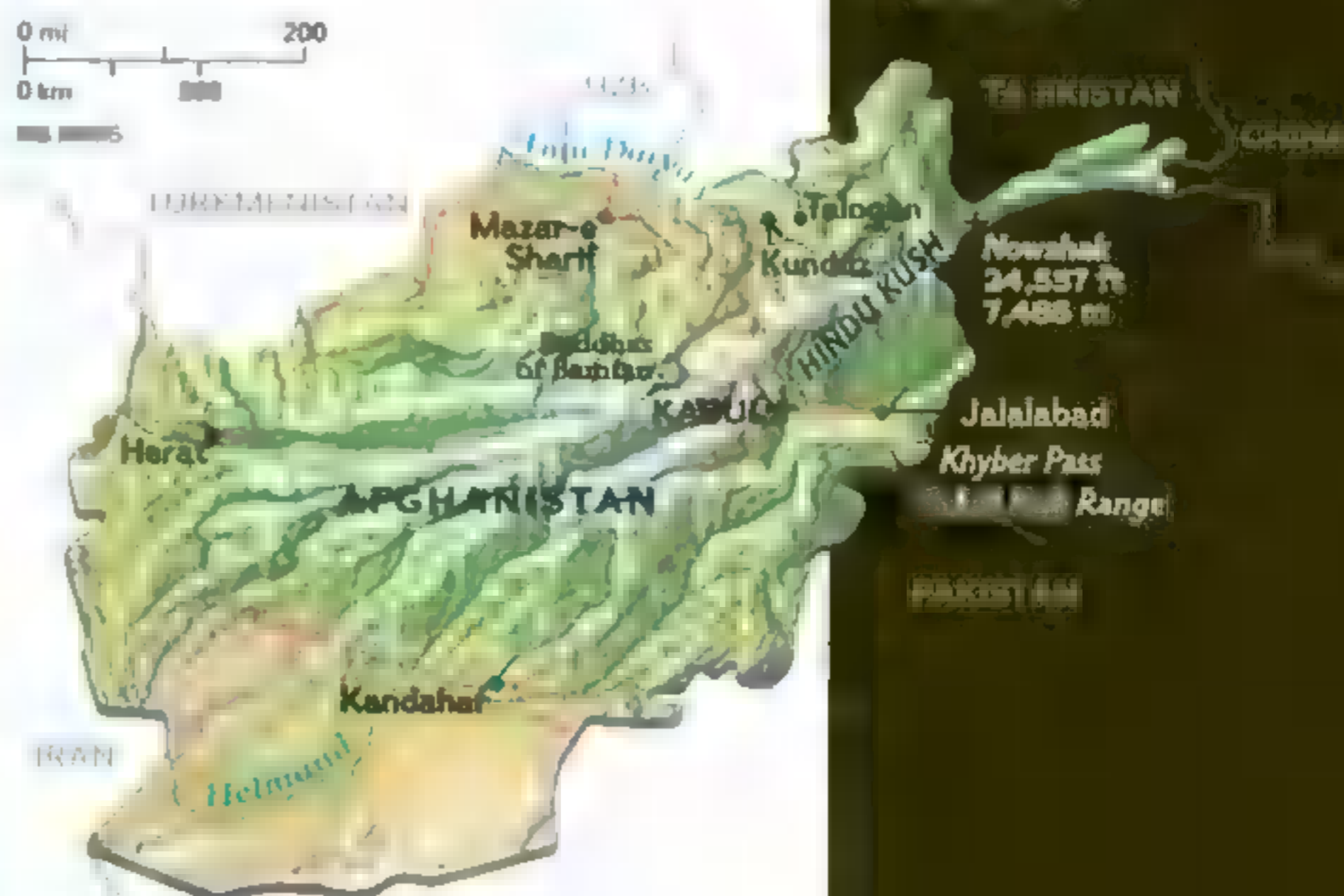


# Afghanistan

laws. The new freedoms emboldened communists to demonstrate, promote strikes, and demand faster reform. Conservatives began to have second thoughts about democracy.

In 1973 Zahir Shah was overthrown by his cousin, Daoud, a hot-tempered autocrat. The king went into exile in Rome as Daoud abolished the parliament and ended the decade of democracy. In 1978 came another coup: Afghan communists, possibly guided by Moscow, assassinated Daoud and took over. Thus began the 23 years of terrible warfare.

Could the optimism of that decade ever return? Consider the arithmetic of Afghanistan: A million and a half people killed. Nearly four million living as refugees, including most of the vanguard of educated men and women. Land mines preventing the use of thousands of acres of precious farmland. Kabul all but destroyed, the university in rubble. Highways, bridges—gone. Experts say it will take at least a decade to rebuild Afghanistan merely to its spare 1960s development level. And many more years to bring it into the 21st century.



## POPULATION

26.8 million

## CAPITAL

Kabul

## LANGUAGES

Dari (Dari) 37%

Pashtu 35%

Turkic 11%

Other 4%

## ETHNIC GROUPS

Pashtun 38%

Other 25%

Hazara 19%

Other 18%

## RELIGIONS

Sunni Muslim 84%

Shiite Muslim 11%

Other 1%

## LITERACY RATE

32% (lowest in the Stans)

## LIFE EXPECTANCY

46.2 years

(lowest in the Stans)

## INFANT MORTALITY

111 per 1,000 live births

(highest in the Stans)

## TOTAL AREA

250,001 square miles

## IN BRIEF

After the Taliban's takeover, many Afghans fled to work, to school, and to the streets.

# Rich Future

*Deposits of oil and gas—if combined with wise government—promise immense wealth.*

**The face of the future projects hope for Kazakhs who a decade ago returned from Soviet exile in Mongolia. Today Kazakh power plants sell energy to Russia.**

The cash is rolling in: 12 billion dollars in foreign investment in the ten years since Kazakhstan became independent and almost 5 billion dollars in 2000 alone from sales of oil.

The largest of the five ex-Soviet Stans (think Texas x 4), Kazakhstan seems likely to also be the wealthiest. The Soviet Union scarcely explored Kazakhstan's oil deposits; now these deposits seem to never stop growing. A newly tested field in the Caspian Sea raises estimates of the country's total proven reserves to as high as 17.6 billion barrels. That approaches the total U.S. reserves, 22 billion barrels.

Even China's national petroleum corporation has joined the multinational companies rushing to Kazakhstan with investment cash. Pipelines already carry oil to the West via Russia, and more

pipelines are on the way. Plenty of natural gas will be flowing too, once a transport system is in place.

The average Kazakh hasn't seen much of the wealth that swells government coffers. To be sure, there are more jobs; thousands of workers have been building the new capital, Astana, in the arid steppe. (It replaces Almaty, once a fortress of Russian Cossacks.) But critics describe a developing "enclave economy" in which money pours into the oil-and-gas industry or benefits a coterie of officials and allies of President Nursultan Nazarbayev. The national unemployment rate is 14 percent; in cities away from the oil fields it's as high as 50 percent.

Inevitably, perhaps—since corruption is a fact of life in the Stans—millions of dollars paid in 1997 by U.S. companies seeking oil concessions ended up in Swiss



BEHND LUDWIG (REARVIEW), IAN BERRY, MAGNUM PHOTOS

banks, in accounts that investigators say were controlled by Kazakh officials, including Nazarbayev. In the West that's called a scandal; in Kazakhstan's intimidated press it hardly got a mention. Personal information about the president is by law a state secret. Publications that have dared criticize him on other matters have been sued or their print runs and equipment have been confiscated.

Nazarbayev was the last Kazakh Communist Party boss, before the Soviet Union's collapse, and has been the new nation's only leader, easily winning reelection in 1999. Critics called the election flawed; for one thing Nazarbayev's strongest opponent was barred from running by Nazarbayev's courts. He

controls the parliament as well as the courts—the old Soviet way. Still, his regime is less repressive than those of neighboring Uzbekistan and Turkmenistan.

The Kazakhs—Turkic tribes whose forebears included the Mongols of Genghis Khan—are the most Russified major group in Central Asia. Russia began to expand into their territory in the 1700s; other Central Asian peoples had little contact with Russians until a century later. Land-hungry peasants poured into the steppe in the late 19th century. In the 1930s and '40s trains brought thousands of people that the dictator Joseph Stalin didn't trust, such as Germans from the Volga region along with Koreans from the Soviet Far East. Yet another wave of settlers arrived in the 1950s to plow the steppe in the Virgin

# Kazakhstan

Lands program, an ill-fated attempt to grow wheat in semidesert conditions.

As they did in other Stans, the Soviets set out to eradicate the local culture. They burned Kazakh books, executed leaders or sent



them to the gulag, and collectivized the farmfolk. Small wonder that many Kazakhs lost touch with their culture and today speak Russian better than their own Turkic language.

Now there's a new culture, of wealth from oil and gas. Perhaps some day there will be a culture of democracy; the government boasts of Kazakhstan's "thriving nascent democracy." Nascent is the operative word, indeed.

## POPULATION

14.8 million

## CAPITAL

Astana  
(was Almaty, Land of the Apples, until 1997)

## LANGUAGE

Russian 60%  
Kazakh 40%

## ETHNIC GROUPS

Russian 53%  
Uzbek 30%  
Ukrainian 4%  
Other 13%

## RELIGIONS

Muslim 47%  
Russian Orthodox 44%  
Protestant 2%  
Other 7%

## LIFE EXPECTANCY

63.3 years

## INFANT MORTALITY

59 per 1,000 births

## TOTAL AREA

1,249,170 square miles

## IN BRIEF

This country remains closely tied to Russia, with which it shares a 4,250-mile border. In 2001 most of Kazakhstan's annual oil production—some 250 million barrels—was shipped to Russia.



THE MOST TRADITIONAL

# Strong Roots

A rural Kyrgyz endures  
in this mountain  
knock-down, posing  
a challenge to a leader  
trying to modernize.



**Ghosts of communism rest eternal in eastern Kyrgyzstan. Under Soviet rule religion was suppressed. But Muslims displayed crude sickles that also evoke the crescent moon—symbol of Islam.**

No Kyrgyz festival is complete until a singer rises to intone stanzas from the longest narrative in world literature. The *Epic of Manas* bulges with half a million lines of verse. Purportedly a thousand years old, it's both the story of a Kyrgyz folk hero—that's Manas—and a hymn to freedom, valor, and the unity of the Kyrgyz tribes.

Scholars aren't certain Manas lived. No matter. In the words of Kyrgyzstan's president, Askar Akayev, the narrative is "our spiritual foundation . . . our pride, our strength, and our hope."

Under the Soviets the epic was banned in schools, except for parts rewritten to conform to Soviet ideology; in Kyrgyzstan as

elsewhere Moscow suppressed ethnic tradition and pride. But Soviet authority did not easily penetrate the soaring Pamir and Tian Shan mountain ranges, and the Kyrgyz who lived there clung to their roots. Shepherds sang of Manas around their campfires and parents handed down verses to their children.

Annexed to Russia in 1876 as part of Russian Turkistan, the territory of the Kyrgyz became a Soviet republic in 1936. The Soviets renamed the capital Frunze, for a general of the Russian Revolution. After 1991 the Kyrgyz took back the city's original name, Bishkek, which is said to mean "five knights." Legend holds that



STATION WINTER

the knights fought one another to possess the enticing site, a valley beneath shimmering mountains.

Today it's hard to imagine knights squabbling over a raffish city of Soviet-style apartment blocks, the home of many of the 603,000 Russians who remain in Kyrgyzstan.

All told, Russians are 13 percent of the population. Another 300,000 have departed, often complaining that jobs were being "Kyrgyz-fied." To encourage skilled technicians to remain, the post-Soviet government in 1996 recognized Russian as an official language alongside Kyrgyz, which, like Uzbek and Turkmen, is a Turkic tongue.

THE STANS

# Kyrgyzstan

Kyrgyzstan's mountains haven't insulated the nation from the turmoil afflicting its neighbors. Bands of guerrillas, part of a radical movement that aspires to create Islamic states, have infiltrated from neighboring Tajikistan, taking hostages and battling Kyrgyz troops.

President Akayev has sometimes used Soviet methods, muzzling critical newspapers and harassing and arresting political opponents or disqualifying them from seeking office. Akayev's own reelection in 2000 was tarnished by stuffed ballot boxes and voter intimidation. Despite state restrictions, an independent press and opposition parties survive.

Trying to shift to a market economy, the Akayev government transformed Soviet-era factories and other enterprises into shareholder companies. But few have been able to find markets, and the government needs cash as it grapples with high unemployment, inflation, and potholed roads.

Central Asian experts say that Kyrgyzstan, already a debtor nation, will need continual shoring up by international lending agencies. The Manas legend may indeed be the country's spiritual foundation; unfortunately, it doesn't pay the bills.

POPULATION

4.8 million

CAPITAL

Bishkek

LANGUAGES

Kyrgyz and Russian (no breakdown available)

ETHNIC GROUPS

Kyrgyz 65%

Uzbek 14%

Russian 13%

Other 8%

RELIGIONS

Muslim 75%

Russian Orthodox 20%

Other 5%

LIFE EXPECTANCY

63.5 years

INFANT MORTALITY

17.7 per 1,000 births

TOTAL AREA

199,000 square miles

IN BRIEF

The *Epic of Manas* recounts the tale of a medieval tribal hero's adventures conquering land for his tribe, and of feasts where guests "ate mountains of meat and drank lakes of *kumiss*," still a favored beverage of fermented mare's milk. Says one expert, "The Kyrgyz think of themselves as the poets and artists of Central Asia."



# Wild Card

*Power broker—or powder keg for a region in chaos?*

**Capitalism thrives in a makeshift grocery on the Karakoram Highway and in the streets of Rawalpindi. Set up by the British in 1947, Pakistan blends East and West.**

It's been called a powder keg and a failing state—"a cat that has used up several of its lives," in the words of one U.S. expert.

The economy is flagging, education is a shambles. For the fourth time since Pakistan came into existence 54 years ago, the army in 1999 ousted the elected government and took control. Afghanistan's wars have flooded Pakistan with weapons, spawning a "Kalashnikov culture," a propensity to settle disputes with modern weaponry, even grenade launchers. Shoot-outs between political parties, or between civilians and police or soldiers, are common in the port city of Karachi, now swollen to 12 million people.

In 1947 Pakistan was created as

a Muslim homeland in the partition of British India. The name is an acronym, coined from some of the new land's regions: Punjab, Afghania (the North-West Frontier), Kashmir, and Indus-Sind. *Pak* happens to mean "pure" in Urdu, the official language. Thus Pakistan is "land of the pure."

Punjab Province, with 59 percent of the population, is so dominant in politics that Baluchi and Pashtun, the peoples of the North-West Frontier, bristle at the "Punjabization" of the nation and demand autonomy. The Pashtun intensify the difficulties, for their homeland is divided by an artificial boundary drawn by the British in 1893. About 11 million live in Pakistan and perhaps the same



BOTH BY ED KASHI

number in Afghanistan, where they are the major population group. Over the years Pashtun on both sides have raised the “Pash-tunistan” issue, as it’s called, demanding a merger of all Pash-tun or at least a plebiscite to decide what nation they will be part of. As Afghanistan stirred this issue in the 1960s, Pakistani officials con-cluded their nation was boxed in by enemies—on the east by India (with whom Pakistan has fought two wars over Kashmir)

their sons to thousands of schools called *madrasahs* that may dis-pense an ultraconservative version of Islam and little else. Many madrasahs also foment hatred of the U.S., calling the attack on the Taliban and Osama bin Laden one of a long list of U.S. offenses against Islam.

# Pakistan

## POPULATION

144.6 million

## CAPITAL

Islamabad

## LANGUAGES

English variants 58%

Sindhi 12%

Pashtu 8%

Urdu 8%

Other 14%

## ETHNIC GROUPS

Punjabi, Sindhi, Pashtun,

Baluchi, Muhajir

## RELIGIONS

Sunni Muslim 77%

Shiite Muslim 20%

Other 3%

## LIFE EXPECTANCY

61.5 years

## INFANT MORTALITY

81 per 1,000 births

## TOTAL AREA

307,374 square miles

## IN BRIEF

Nearly two-thirds of the population of all the

Stans lives in Pakistan,

the world's second most populous Muslim

country, after



and on the west by Afghanistan.

Whatever the future regime in Kabul, Pakistan probably will try to dominate it.

Pakistan has the means to dom-inate; its military, 620,000 strong, is by far the largest in the Stans. And it has the bomb, as it proved in test explosions in 1998, answer-ing India’s nuclear tests.

Defense gets about 30 percent of the government budget. Edu-cation receives less than a tenth as much—even though almost half the nation’s 145 million citizens are under the age of 15. Few rural girls receive any education at all. More and more, families send

The U.S. was once Pakistan’s closest ally, and many Pakistanis probably still respect their old friend. But the relationship could become problematic as Pakistan stumbles toward its uncertain future, carrying its nuclear baggage.



THE WEAKEST

# Crippled Nation

*Besieged by famine, poverty, and warring clans, the smallest Stan is losing its struggle to survive.*

**The calm of an empty street in Yoged belies the trauma of empty stomachs plaguing Tajikistan, now in its third year of drought. International relief helps sustain people in villages like Shahr-tuz, where women and children gather to receive food.**

It was the poorest republic in all the Soviet Union. Soon after independence in 1991 it was plunged into a civil war in which at least 50,000 people died. Most of its trained manpower fled. It's easy to see why some Central Asian experts call Tajikistan a crippled nation that will have a hard time surviving without foreign help.

Tajiks are of Persian stock and speak a Persian dialect. They make up 65 percent of the country's 6.6 million people; most of the rest are Uzbeks who mainly live in Tajikistan's slice of the Fergana

Valley in the north. Many Tajiks have kin across the border in northern Afghanistan. While most of the Tajikistan Tajiks practice a moderate form of Islam, the mountains of their nation have been a hiding place for extremist Muslim guerrillas who have raided into Uzbekistan.

Tajikistan's challenges begin with terrain. Ninety-three percent of the Arkansas-size nation is mountainous. Most of the arable 6 percent was long tilled by state farms that were required to grow cotton. It remains the major crop, but yields and prices have fallen.

Bombs occasionally explode in Dushanbe, the capital. Assassins gun down political leaders and kill others for revenge. Much of the violence is the aftermath of the civil war, a tangled, chaotic, multi-sided power struggle that continued until a cease-fire was signed in 1997, with occasional subsequent eruptions. The fighters: bands of





# Tajikistan

## POPULATION

6.6 million

## CAPITAL

Dushanbe

## LANGUAGE

Tajik, Russian  
(breakdown available)

## ETHNIC GROUPS

Tajik 65%

25%

Russian 3%

7%

## RELIGIONS

Sunni Muslim 80%

Shiite Muslim 5%

15%

## LIFE EXPECTANCY

64.3 years

## INFANT MORTALITY

116 (per 1,000) births

## TOTAL AREA

141,311 square miles

## IN BRIEF

Tajikistan is one of the poorest countries in the world. Forty percent of the people live below the poverty line of 17 dollars a month. Tajiks speak a Persian dialect, one of the oldest in the former Soviet Stans. When the U.S.S.R. collapsed, Tajikistan felt threatened by Iran, Pakistan, and historically, Russia. Like the other Central Stans (all Turkic speakers), it is associated with nomadism. Today many Tajiks get their news by tuning in to radio from Tehran.

communists, Tajik clans, a small Islamic force, and warlords. The warlords were also trying to seize the nation's meager assets, such as textile mills, for themselves. Russia sent troops in 1992, ostensibly to try to halt the fighting and perhaps to extend its influence in Central Asia. The Russian Army presence is still large.

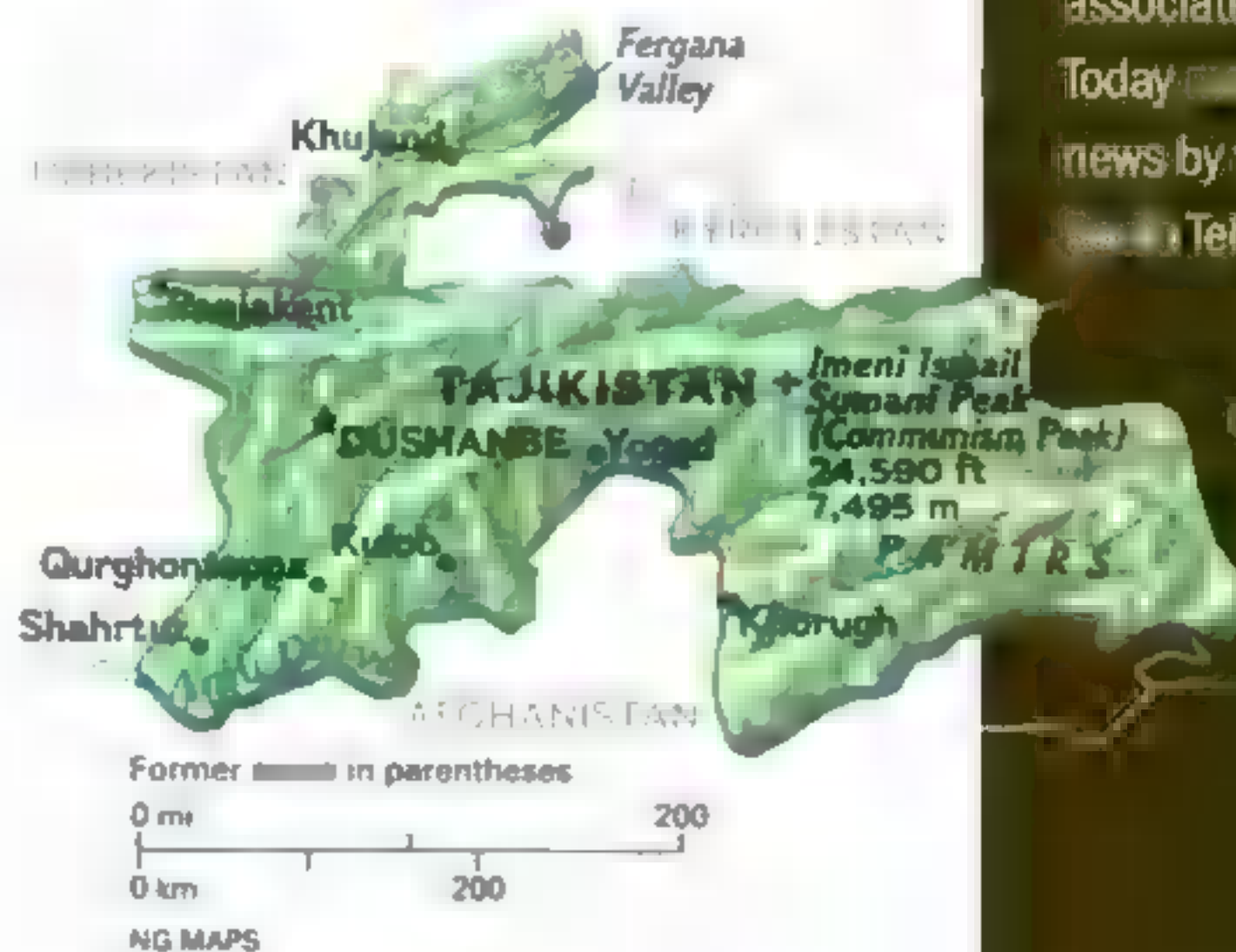
Elections in 1994 gave the presidency to Imomali Rakhmonov, a former state farm boss. Critics say he is allied with militia leaders who control regions of the country and sometimes commandeer businesses. Some commanders may be smuggling opium from Afghanistan, in recent years the world's number one producer.

Tajikistan's biggest industry is a huge aluminum smelter built by the Soviets. Dams on mountain streams generated the necessary electricity, but the ore, bauxite, had to be transported from abroad by ship and rail. The

smelter still limps along, 120 million dollars in debt.

The best hope for Tajikistan may be development of small farms and orchards. The government has allowed some farmers to go private, and many have prospered. The Aga Khan Foundation, a charity active in Central Asia, has seen crop yields double among farmers who received modest loans for seed, fertilizer, and irrigation projects.

Otherwise, not much good news emerges from Tajikistan. Barring a miracle, it will remain poor, and perhaps unstable as well.



# One-man Stan

*A president wields kinglike powers, shackles freedoms, and splurges on luxuries.*

**Whether slaughtering a sheep or tending tomato fields, villagers wring life from a land that is four-fifths desert. Ample oil and gas may one day bring riches.**

A nation of vast potential, with huge reserves of oil and natural gas, Turkmenistan in the ten years since independence has failed to escape from economic mire and harsh Soviet-style control.

President-for-life Saparmurat Niyazov headed the Turkmen Communist Party before the Soviet Union broke up. Now it's called the Democratic Party. It's the only one allowed. Opponents have been thwarted by arrests and harassment. The press is rigidly censored, and state-owned Turkmen Telecom is the sole Internet provider, allowing the government to monitor electronic mail.

Niyazov was unopposed for president in 1992, in the first election after independence. Subsequently his rubber-stamp parliament, the Majlis, decreed that he could remain in office indefinitely. Nowhere in the former

Soviet Stans is the cult of the ruler more intense. The president, who prefers to be called Turkmenbashi, Leader of the Turkmen, has put his likeness on everything from the currency to the local vodka. The main airport is named for him, and so is a city on the Caspian Sea. In Ashgabat, the capital, his gilded statue rotates atop a spire, one revolution every 24 hours. At dawn his outstretched arms reach southeast toward Afghanistan. By noon he faces Iran, and at night falls he is gazing north toward Kazakhstan and Uzbekistan.

Turkmenbashi has steered a neutral course through the region's upheaval, and no guerrillas, Taliban spawned or otherwise, are known to have intruded. Turkmenistan cultivates the friendship of its neighbors in hope of marketing its great store of natural



gas—possibly the fifth largest reserve in the world—and its petroleum. Iran has received Turkmen gas since 1998, and much of it goes to Ukraine and other ex-Soviet nations via Russian pipes. But Russia has refused to transport Turkmen gas to hard-currency nations, retaining the European market for itself. Plans for a pipeline across Afghanistan to Pakistan, of great potential benefit to those Stans as well as to Turkmenistan, foundered because of Afghanistan's turmoil. Another pipeline is more of a pipe dream and would pass under the Caspian Sea to Turkey.

In all, energy exports bring in about 600 million dollars a year, far short of what the president expected when he promised to make Turkmenistan the "Kuwait of Central Asia," with free bread and a Mercedes for every family.

Lack of funds, however, didn't deter Turkmenbashi from launching a radical makeover of Ashgabat, ripping out homes in the center of the city to get a site for his huge new marble palace. On the outskirts of the capital he built some 30 hotels that hardly ever host a visitor. With such splurges the government has run up a 2.3-billion-dollar foreign debt.

The average wage earner, meanwhile, takes home about \$30 a month. Men fortunate enough to own an old Russian Volga—far from a Mercedes—moonlight as taxi drivers to earn extra cash.

Traditional nomads, Turkmen trace their origins to Turkic-speaking tribes that migrated from Mongolia and Siberia in the eighth century. During the Soviet

# Turkmenistan

era Moscow decreed that the Turkmen, like their neighbors the Uzbeks and Tajiks, must settle down on farms and grow cotton for Russian mills. Canals siphoned water from the Amu Darya and smaller rivers in the Turkmen



PHOTO BY JAMES HILL

republic and sent it across great swaths of the Garagum desert. The consequences were dire. Inefficient irrigation, especially leakage from canals, has created more than two million acres of useless salt marshes.

Yet nearly half of the workforce in this nation of great potential wealth still seeks a meager living from agriculture, picking cotton by hand, with few if any benefits accruing from Turkmenbashi's one-man rule.



## POPULATION

4.6 million

## CAPITAL

Ashgabat

## LANGUAGES

Turkmen 72%

Russian 12%

Uzbek 9%

Other 7%

## ETHNIC GROUPS

Turkmen 77%

Uzbek 9%

Russian 7%

Kazakh 2%

Other 5%

## RELIGIONS

Muslim 89%

Eastern Orthodox 9%

Other 2%

## LIFE EXPECTANCY

61 years

## INFANT MORTALITY

13 per 1,000 births

## TOTAL AREA

188,456 square miles

## IN BRIEF

Some experts believe Turkmen rugs are the descendants of the purest and oldest of all carpet-weaving traditions in Central Asia. The rugs are made in Bukhara after the town was destroyed and were sold in neighboring Uzbekistan.

THE MOST REPRESSIVE



# Ministry of Fear

*Following old Soviet ways, the government keeps an ironclad grip on the press and political foes.*

**Blunting the assaults of history since the 16th century, the Ark Citadel repels the elements on a winter day in Bukhara. Showing similar resolve, locals in Khiva bundle up and eat out. With an appetite for religious militants, the government has adopted a fortress mentality toward radical Islam.**

It's risky to be a pious Muslim in Uzbekistan. The security forces have cracked down so hard on suspected Muslim militants that men come under suspicion who merely grow a beard or who belong to a religious family.

Thousands have been arrested. A U.S. State Department human rights report cites case after case of suspects who were beaten in jail, were forced to sign bogus confessions, or died in custody.

The Uzbek government blames Muslim militants for a series of explosions in Tashkent, the capital,

in 1999—apparently an attempt to assassinate President Islam Karimov—and for guerrilla attacks in the Fergana Valley, the richest farming area. The largest radical group, said to have a few thousand fighters, calls itself the Islamic Party of Turkistan, using the name once applied to a broad swath of Central Asia. It has vowed to install Islamic regimes not only in secular Uzbekistan but in all the neighboring Stans as well.

Raids and acts of terrorism are the reason the Uzbek government gives for its harsh treatment of men who appear to be devout Muslims. Critics say many of those arrested are innocent, merely following their faith, and that some are political opponents of President Karimov.

Like their neighbors the Kazakhs, Uzbeks are a Turkic people who mixed with the conquering Mongols of Genghis Khan. They have managed to hold on to their





BRUNO BURELLI, GUEORGUI PINKHASSOV, MAGNUM PHOTOS

# Uzbekistan

## POPULATION

25 million

## CAPITAL

Tashkent (Stans city with a subway)

## LANGUAGE

Uzbek 74%  
Russian 14%  
Tajik 4%  
Other 8%

## ETHNIC GROUPS

Uzbek 80%  
Russian 6%  
Tajik 5%  
Kazakh 3%  
Other 6%  
(ethnically diverse of the Stans)

## RELIGIONS

Muslim 88%  
Eastern Orthodox 9%  
Other 3%

## LITERACY RATE

99% (highest in all the Stans)

## LIFE EXPECTANCY

63.8 years

## INFANT MORTALITY

72 per 1,000 live births

## TOTAL AREA

172,742 square miles

## IN BRIEF

Some Muslims here practice Sufism, a mystical, less formal form of Islam.

culture better than the Kazakhs, and they're proud that in the 10th to 15th centuries the cities of Samarkand, Bukhara, and Khiva nourished poets, mathematicians, and astronomers. The savage warrior Tamerlane, born near Samarkand, is a national hero, admired as a conqueror who ruled from Persia to India.

Agriculture is Uzbekistan's biggest employer, and cotton is king, as it was in Soviet days, when irrigation canals were stitched across the arid landscape and groundwater became polluted with agrochemicals. State farms, also Soviet relics, have not been abolished, and the government still tells farmers what to plant: cotton. The system enriches the state at the expense of the peasants, for the crop must be sold to the state at a fraction of its value.

Nearly half of Uzbekistan's 25 million people, a population

almost half that of the five former Soviet Stans, are under 18. Nearly all have a basic education (give the Soviet system credit for encouraging universal schooling). But jobs are scarce, and inevitably some of the jobless are attracted to militant Islam. As a U.S. official said: "They go off to Pakistan to study religion [where many Taliban leaders studied], and they go from learning about the Koran to learning about Kalashnikovs." □

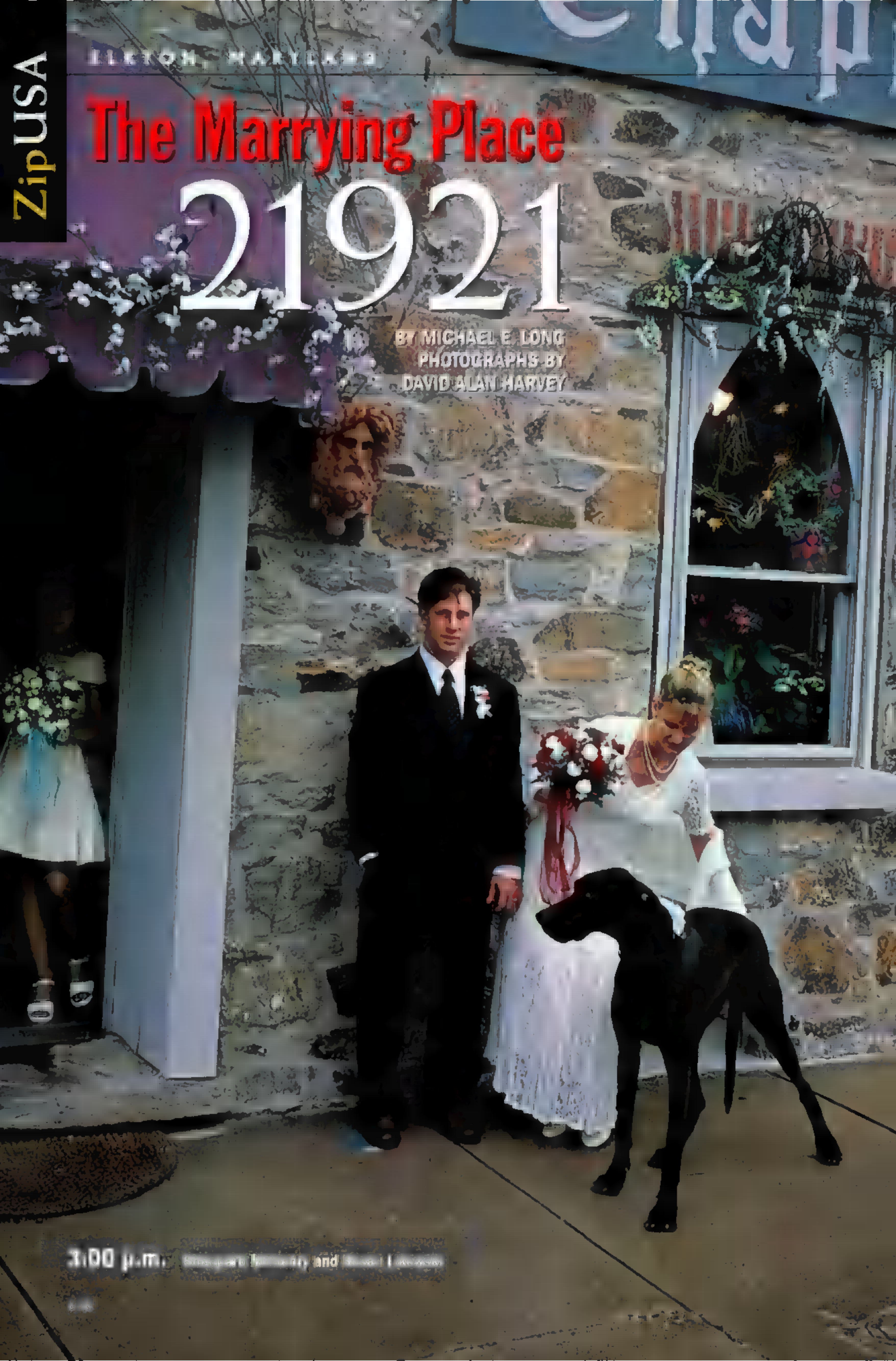


ELKTON, MARYLAND

# The Marrying Place

# 21921

BY MICHAEL E. LONG  
PHOTOGRAPHS BY  
DAVID ALAN HARVEY



3:00 p.m. St. Ignace Primary and School, Elkton



Chapel

11:00 a.m. John Reading and Linda Whitman

**Amiable citizens** walking quiet streets with an easy air—the generics of small-town America—make Elkton, Maryland, not much different from other towns scattered above the northern reaches of the Chesapeake Bay. Then why do thousands of people travel here each year to get married, even folks of prominence from times gone by? Ethel Merman, Bert Lahr, Joan Fontaine, and Cornel Wilde, movie stars; John Eisenhower, son of Ike; John Mitchell, former attorney general; singers Billie Holiday, Screamin’ Jay Hawkins, and Maxene Andrews of the Andrews Sisters; and sports luminaries—Willie Mays, baseball, Jersey Joe Walcott, boxing, and Charles Barkley, basketball. What swirl of gravity draws them to Elkton, population 12,000, zip code 21921?

Answers are sought at the fire department’s annual antique sale, where a visitor inquires after a certain Mr. . . . “Dixon?” responds Don Herring, ticket taker and retired editor of *The Cecil Whig*. “I think I saw the sheriff taking him away.” Kermit DeBoard, an antiques dealer, points to a tall man in a striped shirt loitering near the stemware. “Looks like he’s stealing something,” DeBoard says. The veins of drollery run deep here, it seems.

Confronted, the suspect identifies himself as Mike Dixon, historian of the Historical Society of Cecil County. We sit to slices of Impossible Pie, served by Nancy Caldwell, who explains that it is just impossible not to make it taste good. Dixon harkens back to 1913, the year neighboring Delaware imposed a four-day waiting period on marriages. Maryland had no such waiting period, no blood test, no nothing to delay the union of eager couples heading south from Delaware into Maryland. “Elkton was the first county seat they hit,” says Dixon. When the word got around, more couples began arriving from other states to the north. In 1936 the town issued 11,791 marriage licenses. Taxi drivers met trains and buses and vied for couples in competition that sometimes included

**“I’ve done 35,000 marriages, give or take, in 18 years,” says Janice Potts.**

**Movie stars, athletes, and just plain folks have exchanged vows before Janice Potts, deputy clerk at the courthouse. Once, Maryland’s lax marriage law drew elopers. Now nostalgia guides nuptials.**



**2:00 p.m.** Ann Wright and Taurus Hollis



**4:00 p.m.** Kelly Underwood and Edward Taylor



# SOMETIMES IT'S NOT JUST THE STRENGTH OF YOUR CHARACTER THAT'LL SAVE YOUR LIFE.

*It's the*  
STRENGTH OF A DOG'S TEETH.

Trapped. Unforgiving seas pounding your family ever closer to jagged rocks. With distress signals sent, all you can hold on to is a glimmer of hope. And it arrives from above as a powerful dog and her trainer leap from a rescue helicopter. "Throw her the rope," her trainer implores. "Trust the



strong, healthy teeth to save lives. And to make sure this Newfoundland's teeth stay in peak condition, her trainer feeds her Eukanuba®. Now the only dog food with the dual-action Dental Defense System.

This breakthrough science works both during and after meals to help reduce tartar build-up by up to 55% [see inset].



Available in all adult Eukanuba formulas, the Dental Defense System is an essential part of the Eukanuba Vital Health System,™ developed for optimal overall canine health.

Find Eukanuba in specialty pet stores. And know that the Dental Defense System keeps a dog's teeth in peak condition. Whether that dog is saving lives, or simply enriching them.

**THE NEW EUKANUBA DENTAL DEFENSE SYSTEM™ WITH DUAL-ACTION.**

Dog A  
Fed Eukanuba Control Diet

Dog B  
Fed Eukanuba with Dental Defense System

Images taken with UV camera. Yellowish-brown areas represent tartar buildup after 28 days of feeding (Eukanuba Control Diet vs. Eukanuba with Dental Defense System). A professional dental cleaning was performed prior to the images. Average tartar reduction of 55%.

dog." With little choice, you do. To your disbelief, the dog grabs the rope with her teeth, and pulls your family to safety.

Just another day for Mas, a 120-lb. water rescue dog that relies on her



**Eukanuba**  
Results. Guaranteed.™



knockdown fights. The cabbies delivered their trophies to favorite ministers in about a dozen small marriage chapels.

"Marriage, that's what the town lived on," says Tony Trotta, a barber on Main Street. "Everybody was making money." When Trotta began cutting hair here in 1935, the shop contained a jewelry store. He chuckles. "A man could stop in for a haircut, a shave, and a wedding ring."

Maryland voted in a two-day waiting period in 1938, and the conubial tide ebbed. Elkton felt the pinch, even the historical society. Seeking revenue, Mike Dixon and a cohort started a program of Ghost Walks to lure frisson-seeking tourists to sorties through dark cemeteries and creaky houses—who does not shiver before the ghost of Holly Hall? This spacious, redbrick residence was built in the early 1800s.

Helen Warburton's Chesapeake Bay retriever apparently got the shivers. Mrs. Warburton ran the United Way from her office in Holly Hall and remembers the dog peering up the stairs one day, growling, "every hair on her back standing up." Mrs. Warburton, a pillar of the community, saw nothing. "The dog saw something," she soberly maintains. "I don't believe it was a living person." Could it have been the spirit of a patriot—as some believe—banished by his Tory father from Holly Hall?

Now it is time for frissons of a different kind. Today is Valentine's Day, and despite a weeping drizzle, Cupid is back in town. Thirty couples, drawn here by Elkton's reputation as the marrying place, will plight troth, 21 in the courthouse and nine in the one remaining wedding chapel. Cooling in the chapel parlor while his bride Linda Whitman primps upstairs, John Reading displays socks with hearts and a brave red tie, chosen by Linda, he says. John is reluctant to reveal another item Linda picked for him—silk boxer shorts emblazoned with red hearts on a field of black. "He's a Harley man," says Linda. "He can deal with it."

Later, Sheppard McHenry and his bride, Susan Likowski, with her

21921

**POPULATION:** 12,000

**WEDDINGS:** 2,000 annually

**HITCHED HERE:** Billie Holiday, singer; Pat Robertson, evangelist; John Mitchell, former U.S. attorney general; Charles Barkley, basketball player; Jersey Joe Walcott, boxer; José Capablanca, chess champion.

**BEST WHAT?:** A couple once brought their cat—dead and stuffed—to serve as "best man."

**NAME:** Known early on as "Head of Elk," for its location between Big Elk and Little Elk Creeks.

**Still each other's Valentine, the Bergers return to the Little Wedding Chapel to renew their vows after ten years of marriage.**



12:30 p.m. Arnie and Cheryl Berger

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daughter, April, are accompanied by a three-year-old ring bearer named Emma, who tires during the ceremony and goes to sleep at the couple's feet. At the appropriate time Emma surrenders the rings, fastened to a collar around her neck. Emma rears enthusiastically and places her forelegs around the bride's neck and licks her face. Emma is a Great Dane.

At the courthouse across the street Janice Potts, deputy clerk, has married 15 couples before lunch. Then Leonard Irving, a waiter, arrives with Imelda Ornelas, a housekeeper originally from Veracruz, Mexico. José Gallinat, a friend who escaped from Cuba in 1960, translates Potts's words into Spanish for Imelda. The scene touches everyone.

Besides making marriages, Elkton manufactured 40-millimeter shells during World War II in buildings now occupied by Thiokol Propulsion, who won't tell you about the classified stuff they're making, just that it relates to Space. At the nearby Gore-Tex factory I ask why my expensive fishing jacket, made with the waterproof fabric, gets wet in the rain. "Didn't wash it, didn't dry it, did you?" asks Cynthia Amon, Gore-Tex associate. Washing and drying, I learn, regenerates the material. I am escorted upstairs to view dozens of washers sloshing swatches of newly made Gore-Tex for as long as 250 hours. I am told that if the fabric leaks water after being dried, the batch will be discarded. I am impressed.

On a cool afternoon Mike Dixon, who has documented that George Washington passed through Cecil County at least 46 times, takes me to Elk Landing south of town. Here oak and beech trees branch near Little Elk Creek as it eases toward the Chesapeake. "In the War of 1812, 200 British Royal Marines rowed up this river and fired on our local militia right there," he says, pointing to a knoll. Noting the legendary toughness of His Majesty's marines, Dixon exults, "That day we whipped the British!"

Britannia has taken its revenge. No member of the royal family has ever been married in Elkton. □

**MORE INFORMATION**

**ON OUR WEBSITE** There's more on 21921 ■ [nationalgeographic.com/ngm/0202](http://nationalgeographic.com/ngm/0202). Tell us why we should cover **YOUR FAVORITE ZIP CODE** at [nationalgeographic.com/ngm/zipcode/0202](http://nationalgeographic.com/ngm/zipcode/0202) ■ mail your suggestion to PO Box 96095, Washington, DC 20090-6095. E-mail: [zip@nationalgeographic.com](mailto:zip@nationalgeographic.com)

**Emma, a Great Dane, bore wedding rings ■ her collar and smooches the bride ■ the amusement of her daughter, April, and husband, Shep.**



I want to share in her happiness

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Sometimes I wonder which one of us has more wisdom and which one has more joy. And we both thank plastic. Because it's more than a toy:

It's in my hip replacement and my hearing aid, so I can help her see that nothing will hold me back.

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# Final Edit



**MOUNT ETNA**

## Paroxysm of Fire

The Sicilian night shook with earthquakes as Carsten Peter waited for this shot last July 17. After several days on Mount Etna he had almost decided to leave “because nothing was happening.” But he was determined to capture one of the quick, intermittent displays—called paroxysms—that had been occurring that summer. When the southeast crater finally blew at 2 a.m., he got his chance. The sky bloomed; fountains of magma shot 600 feet high (above), lobbing hot missiles toward Carsten, who worked at a safe distance, 2,000 feet away. He kept shooting until the action subsided. Then, as he prepared to leave, a fissure split the foot of the crater, and glowing lava started to spill. “This image,” he says, “turned out to be the last paroxysm before Etna’s big July eruption.”

**MORE ON OUR WEBSITE**

You can send this picture as an electronic greeting card at [nationalgeographic.com/ngm/0202](http://nationalgeographic.com/ngm/0202).

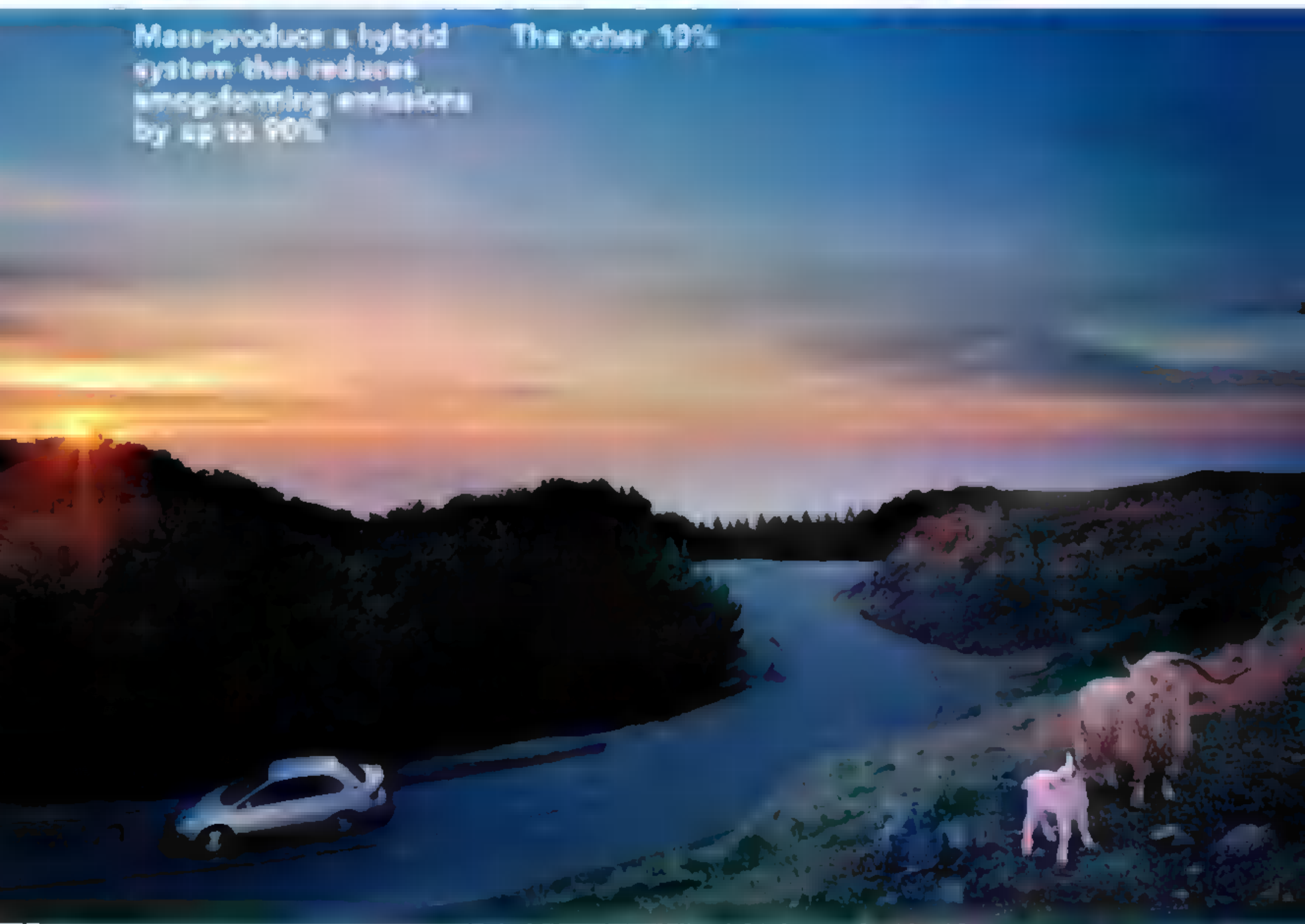
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The other 10%.

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\*Based on the emissions of a typical gasoline engine. Emissions of nitrogen oxides compared to the average car.

# Challenges for Humanity

## When Epidemics Shake the World

**T**hey are too small to be seen with the naked eye, but disease microbes are among the most powerful forces on the planet, stopping armies, ending dynasties, decimating populations. The challenge has been to control them—and the ailments they cause (see “War on Disease,” pages 4-31). Until the 20th century there were few remedies for serious illnesses, and little could be done to keep contagious ones from spreading. Mass infections such as the plague, which is thought to have killed one in four Europeans during the 14th century, were often explained as divine punishment. The truth is more complex: A subtle interplay among microbe, host, social conditions, and environment lies behind every epidemic.

In an epidemic a fast-spreading disease affects large numbers in one location. A pandemic is an epidemic spanning continents. As people increasingly traveled around the world, diseases did too. Traffic along trade routes dispersed sickness as efficiently as it did wealth. Malaria was unknown in the Americas before the first European explorers arrived in the 15th century; by

the 19th century it was firmly rooted as far west as California.

Conditions must be right for epidemics to take hold. Climate, sanitation, and the health of susceptible subjects all play roles in an infection's success. Survivors of some diseases, such as yellow fever, build immunity, making later outbreaks less likely. Other diseases are masters of transformation. Influenza can mutate so rapidly that immunity to one

year's strain may not protect a host from the next year's version. And it can spread swiftly. In the 1918-19 pandemic influenza traveled faster and farther than any other killer disease in history. Each year health officials scramble to develop a new vaccine and to deliver it before the new flu can outpace distribution.

—Margaret G. Zackowitz  
Senior Writer

### How Sickness Spreads

Though many diseases have menaced humans over time, microbes are transmitted in only a few ways.

Some are invited in: Dysentery and cholera are consumed with contaminated water or food.

Others are delivered by insects. Yellow fever and malaria arrive in the bite of certain mosquitoes. Bubonic plague is spread from rodents to people by fleas.

Perhaps the most common form of transmission involves breathing airborne germs exhaled by an infected person. Tuberculosis and influenza usually spread this way—and smallpox used to be. Millions died of smallpox before a vaccine was developed and implemented worldwide; the last naturally occurring case was diagnosed in 1977. Today the smallpox virus is known to exist only in two laboratories, one in the United States, the other in Russia.

#### DYSENTERY

More Civil War soldiers died of diseases, especially this one, than in battle.

#### YELLOW FEVER

French construction of the Panama Canal was halted in 1889 when workers fell ill with this and other tropical diseases.

#### SMALLPOX

Arriving with Europeans in the 1520s, smallpox led in part to the fall of the Aztec in Mexico and the Inca in Peru.



#### MORE ON OUR WEBSITE

For news from the Centers for Disease Control and Prevention about specific illnesses, check out “Resources” at [nationalgeographic.com/ngm/0202](http://nationalgeographic.com/ngm/0202).  
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**Francisco Pizarro**  
1532: Smallpox was his ally in Peru.



**Princess Anne and her son, William, Duke of Gloucester**  
1700: Smallpox ended their bloodline.



**Wilbur Wright** 1912: Typhoid terminated his [redacted].

**Charlotte Brontë** 1800s: She suffered from tuberculosis.



**Napoleon Bonaparte**  
1803: Yellow fever was his enemy in the Caribbean.

## Personal History

Infectious diseases have cut short careers as well as military campaigns, sending ripples through history.

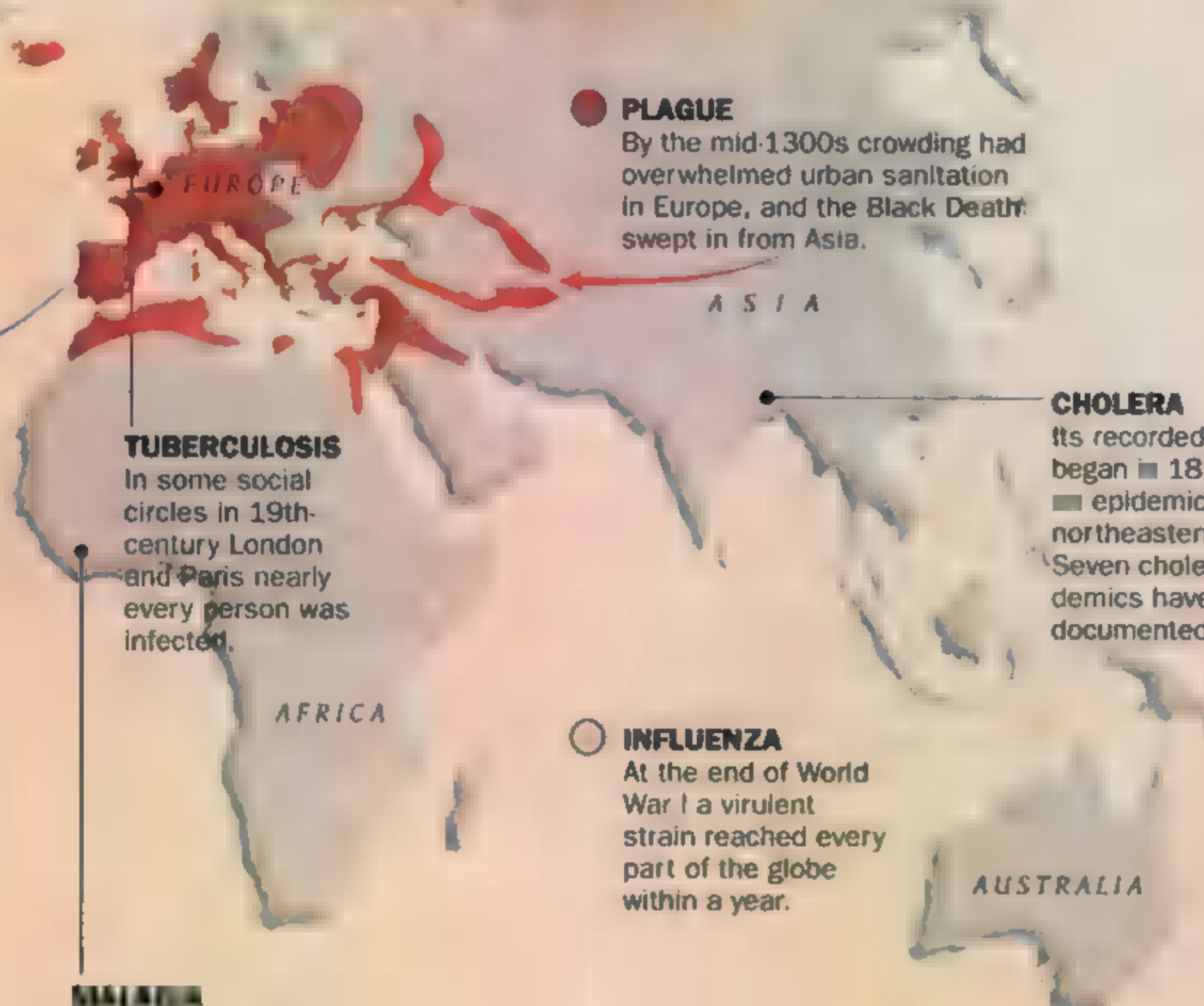
Tuberculosis afflicted the Brontë family, including Charlotte, author of *Jane Eyre*. Weakened by TB, she died at 39 in 1855.

William, sole heir of Princess Anne, died of smallpox in 1700. As queen of England, Anne knew she would be the last of her British bloodline to rule.

In 1896, while his brother convalesced from typhoid fever, Wilbur Wright decided that they should build a flying machine. Sixteen years later Wilbur himself [redacted] dead of typhoid.

In 1532 Pizarro's conquistadores found the Inca of Peru already reduced by smallpox, introduced in the Americas a decade earlier.

Yellow fever hit Napoleon's Caribbean garrisons [redacted] hard it helped persuade him to give up hope of empire [redacted] the New World and sell Louisiana to the U.S. in 1803.



**PLAGUE**  
By the mid-1300s crowding had overwhelmed urban sanitation in Europe, and the Black Death swept in from Asia.

**TUBERCULOSIS**  
In some social circles in 19th-century London and Paris nearly every person was infected.

**CHOLERA**  
Its recorded history began [redacted] 1817 with [redacted] epidemic in northeastern India. Seven cholera pandemics have been documented since.

**INFLUENZA**  
At the end of World War I a virulent strain reached every part of the globe within a year.

**MALARIA**  
Trading voyages spread this tropical disease from Africa to the New World.

# ON ASSI

ON THE ROAD IN THE FIELD

BIG

## Return to Mount Etna

*A volcano erupts, up close and very personal*

**H**e first saw Mount Etna at the age of 18, visiting with his parents from Karlsruhe, Germany. The desert was awakened in me," photographer Carsten Peter says. "As soon as I was able to travel on my own, I went to Mount Etna. It is my little volcano."

But he had never seen the mountain erupt the way it did last summer, when he spent a week huddled up in an abandoned

observation station as the mountain exploded around him. "Most people are fascinated by films of volcanoes," says Carsten, who has also covered glaciers in Greenland, caves in Chile, and volcanoes in the South Pacific and Russia for NATIONAL GEOGRAPHIC. "For me, that's not enough. I have to see it in reality, eye to eye."

# GNMMENT

C O V E R I N G T H E W O R L D



## DISEASE/HIV

## On the Front Lines

Participant as well as observer, photographer **Karen Kasmauski** administers a dose of polio vaccine to a baby in Dhaka, Bangladesh (right). Karen became inspired by public health workers she met around the world as she sought ways to visually tell the story of humans and disease. "These incredible people are frontline soldiers, doing things on very small budgets but accomplishing great results," she says. "They find simple solutions that work."

Karen also photographed this issue's article on HIV/AIDS, working with staff writer **Michael Klesius**. Among the people Mike interviewed was Phimjai Inthamoon (right, with Mike), herself HIV-positive, who has founded a group in Chiang Mai, Thailand, that links local



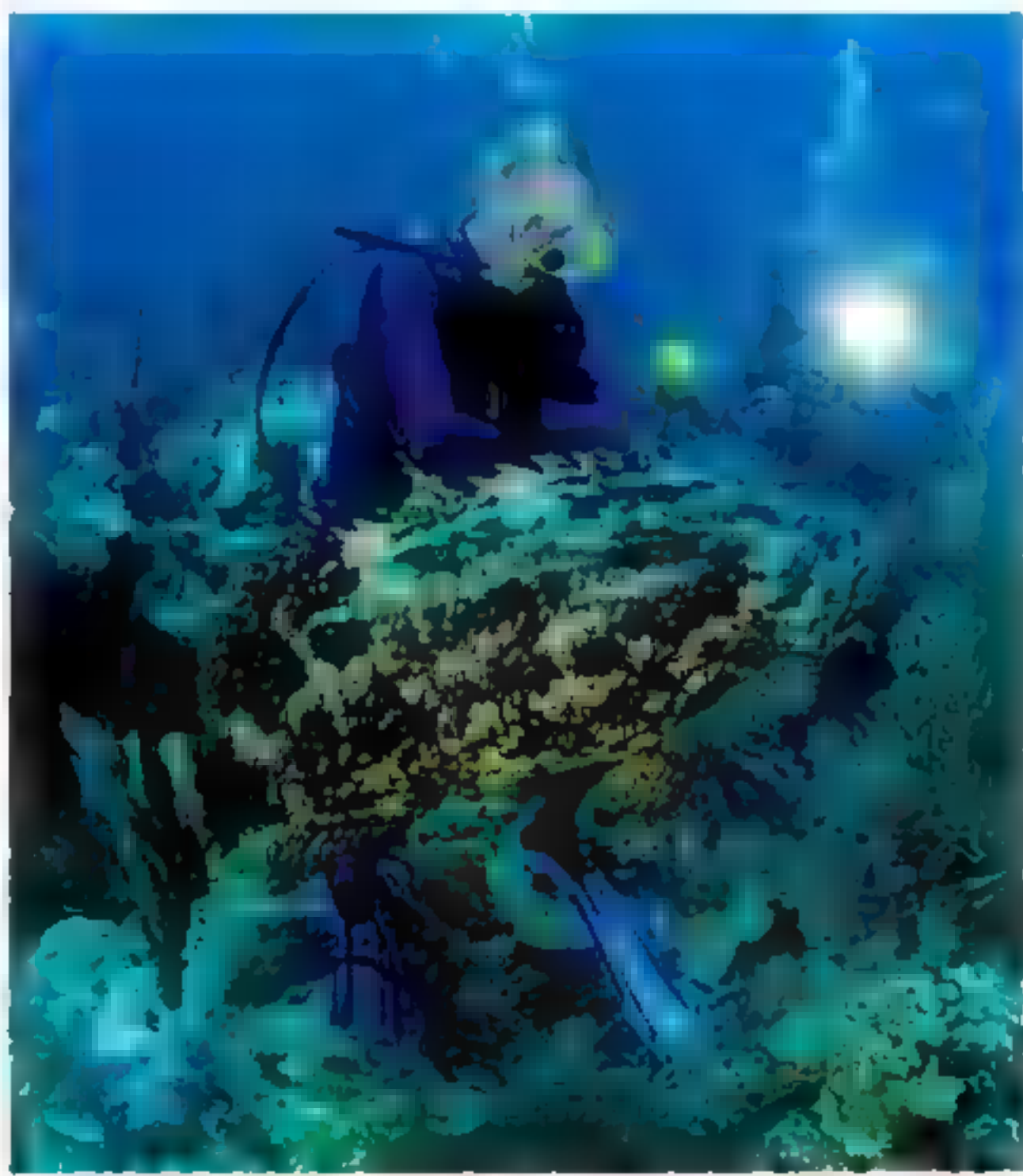
HIV-positive residents with Buddhist monks to assure those infected that others still care about them. "I met ordinary people like her in the trenches, out in the communities, reaching out to people suffering from this disease," Mike says, echoing Karen's words. "The challenges of the disease are daunting, but I came back more optimistic than I had been."



COURTESY BY KAREN KASMAUSKI

## WORLDWIDE

Author **Peter Benchley** (below) "begged for the chance" to write our article about Cuba's reefs, to see Cuba on land and in the water. "I did a story for the magazine on the Cayman Islands



in the 1980s," he recalls. "That's the closest I ever got to Cuba, geographically next door but essentially ■ world away. Because of the isolation Cuba has endured for the past 40 years, much of it

has been untouched by divers."

**David Doubilet** is renowned as one of the world's great underwater photographers. But he ■■ delighted to be in the air too this time, flying over the Caribbean in ■ 1949 AN-2 Russian biplane. "I love old airplanes," says David. "They're my secret passion and thrill." From the venerable craft he made aerial images of the Cayo Largo

reefs. "It's important to fly when you're doing an underwater story," he says. "You get an idea of what the underseascape looks like."

Call **Marco Pinna**, author of our article on Mount Etna, ■ pioneer: An editor for our Italian-language edition, he's the first staffer from one of our 20 local-language editions to pen an article for the English-language magazine. Marco rushed from Rome to Sicily as the show started. "It was absolutely breathtaking," he says. "When the sun went down, the whole mountain lit up."

## MORE ON OUR WEBSITE

Find ■■ stories from our authors and photographers, including their best, worst, and quirkiest experiences, at [nationalgeographic.com/ngm/0202](http://nationalgeographic.com/ngm/0202). AOL Keyword: NatGeoMag

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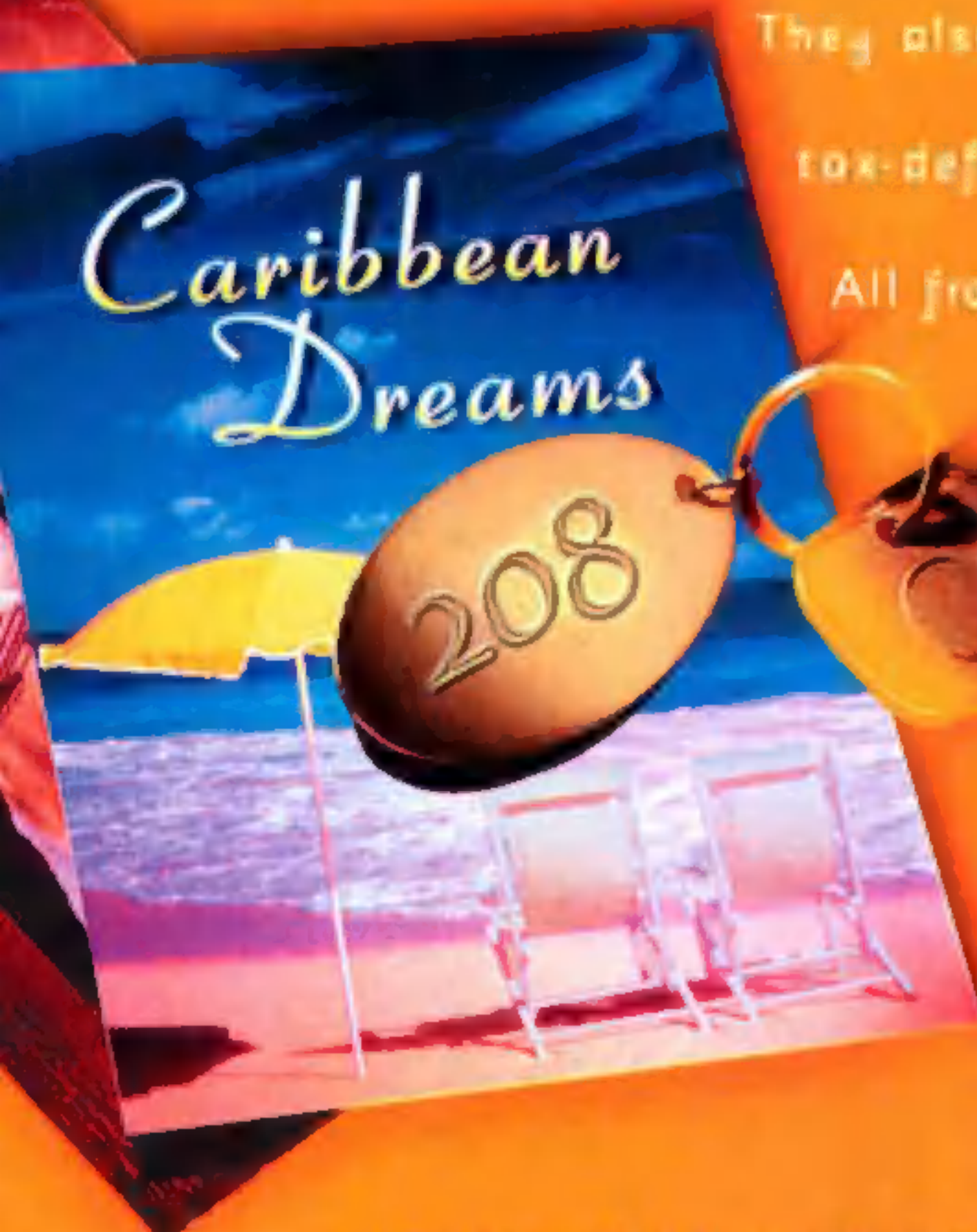
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# Flashback



G. B. HUBBARD

## DOORWAYS OF DISEASE

### Angels in Disguise

“These very alarming persons are not, as might be supposed, night riders or vigilantes surreptitiously disposing of a victim,” assured this photo’s caption in the *GEOGRAPHIC*’s April 1910 portfolio, “Scenes in Italy.” Instead the men—masked to protect their anonymity—belonged to a secret society known as the Brethren of the Misericordia. As penance for their sins, or to “fulfill some vow,” members transported the sick to hospitals, buried the dead, and collected money for the poor.

#### MORE ON OUR WEBSITE

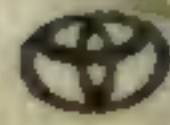
You can send this month’s Flashback as an electronic greeting card and access the Flashback photo archives at [nationalgeographic.com/ngm/flashback/0202](http://nationalgeographic.com/ngm/flashback/0202).  
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*what would  
you dream of doing tomorrow  
if tonight you had  
the best sleep of your life?*

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to embrace the dream of a new day.

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AND INTO THE GORGE AND UP THE  
MOUNTAIN AND UNDER THE CLIFF  
AND BETWEEN THE BOULDERS AND  
PAST THE SWITCHBACKS AND INTO  
THE STREAM AND BEYOND THE RIDGES  
TO GRANDMOTHER'S HOUSE WE GO.